LARS Contract Report 013181

Final Report

Training Course Entitled

Remote Sensing for Mineral Specialists
Part II - Digital Techniques

Award No. AA-510-PPO-6

Reporting Period: September 15, 1980 through January 31, 1981

Submitted to: Bureau of Land Management
Denver Federal Center
Mr. Jean Juilland, COAR

Principal Investigator: Shirley M. Davis
Laboratory for Applications of Remote Sensing
Purdue University
West Lafayette, Indiana 47906

January 1981

CONTENTS

APPENDICES

I. INTRODUCTION

Purdue University, under contract to the Bureau of Land Management, developed and presented a course entitled "Remote Sensing for Mineral Specialists-Part II: Digital Techniques." This course was presented to BLM geologists December 15-19, 1980, at the Denver Federal Center. As part of the contract, the course was carefully documented and evaluated so as to facilitate future offerings of this course.

II. PREPARATION FOR THE COURSE

The teaching staff of the course included the following Purdue staff members:

Shirley Davis, Course Coordinator
Luis Bartolucci, Geophysicist and Program Leader for Technology Transfer
Paul Anuta, Research Engineer
Don Levandowski, Geologist and Head of Geosciences Department
Dave L'Heureux, graduate student in Geosciences.

In working out the arrangements for this course, it was established that EROS Data Center would provide assistance in teaching the Hands-on exercises using the IDIMS at BLM/Denver. Donna Scholz, of Technicolor Services, Inc., was therefore assigned to carry out this work in parallel with Purdue's course.

To prepare for the course, Shirley Davis and Donna Scholz visited BLM in Denver on October 1-3, 1980; Don Levandowski joined them October 3, 1980. The purpose of the visit was to meet with the COAR, Jean Juilland, to discuss course objectives, course content, logistics, and contractural matters. In addition both Ms. Scholz and Davis used the IDIMS system in Denver to become familiar with the user environment and to review the processors planned for hands-on use during the course. Further coordination between Ms. Scholz and the rest of the staff was made possible through her visit to LARS on October 23-24, 1980.

The General and Specific Course Objectives (Appendix A) and the Final Course Schedule (Appendix B) were drawn up as a result of these meetings and of others with the LARS course staff. Although there were modifications in the course schedule during the week of the course, the schedule stood largely as planned. One innovative aspect of the schedule was the four-hour period each day set aside for individual work, such as IDIMS exercises and laboratory exercises, and lunch. The necessity for this arose from the fact that there was only one video monitor available for hands-on instruction, and even with two terminals available, this was not an ideal situation for giving adequate hands-on experience to a group of sixteen. This block of "individual work" time allowed us to make the best use of the equipment during the hours it was available. J. Juilland made all arrangements for our use of the training room and the IDIMS facility.

Three weeks before the start of the course, preliminary materials were sent to the sixteen registered students, listed in Appendix C.

III. PRESENTATION OF THE COURSE

The course was held December 15-19, 1980, for the thirteen participants listed in Appendix D. Of the thirteen, eleven had been students in Part I of the course offered by Purdue in March 1980. The other two had taken Part I of the course when it was offered by EROS Data Center a few years earlier.

The actual course schedule used appears in Appendix B. The only changes that were made came as a result of the mid-course evaluation and the students' request to see more practical examples in lieu of material that aims to develop a conceptual understanding of the topics. The schedule for Thursday was the only part affected.

The possibility of using the IDIMS in lieu of slides during the lectures (with the image projected on a large screen) opened up an interesting method for demonstrating interactive processing, and this technique figured into the schedule change.

For the Hands-on work, the students were divided into six groups, with attention given in the pairings to the type of land areas they were normally working with. The five pairs and one trio for the Hands-on work were:

Group #1: Anderson, Watson
Group #2: Stevens, Tarshis
Group #3: Drew, Pierce, DeHenaut
Group #4: Ryder, Eddy
Group #5: Hankins, Rimal
Group #6: DiPaolo, Barrell

Each group worked on the IDIMS approximately four to four-and-a-half hours during the week, with the possibility of additional time on two evenings. Even though the pairs (and trio) stayed constant, the groups did not always do the Hands-on work in the same order. The optional Hands-on sessions were not well-attended; one person came on Tuesday evening and three on Thursday evening.

Certificates from Purdue University were presented to students upon completion of the course.

IV. COURSE DOCUMENTATION

Complete course documentation was prepared to enable BLM to teach this course themselves in the future. The total documentation is contained in four units:

1) One notebook of Student notes, containing course syllabus, handouts, imagery.

2) One notebook of Instructor's notes, containing annotated slides, materials for making transparencies, answers to the exercises.

3) Videotapes of the actual presentations, with emphasis on the lectures and discussions that involved the entire group.

4) Sample copies of imagery, maps, and printouts used during the course.

The most complete documentation of the course is the seventeen 3/4-inch video cassette tapes. An index to these tapes appears in Appendix E. Even though they are black-and-white and unedited, the videotapes capture the content of the course better than any other part of the documentation and can thus become an essential resource for planning future courses. A word of caution is in order, however: these tapes were created for the instructor who is already familiar with remote sensing; they are not of high enough quality to serve as self-instructional tools for those wishing to learn this material.

V. EVALUATION OF THE COURSE

Evaluation of the course took place four times, with different groups of people. First of all, the students evaluated the course orally on Wednesday morning. This "mid-course evaluation" was moderated by Shirley Davis and is included on Videotape 7.

A formal, written evaluation was completed by the students at the conclusion of the course. Twelve of the thirteen participants returned evaluations, which have been compiled and appear in Appendix F.

Staff evaluations were held twice; first Dr. Levandowski and Ms. Davis met with Mr. Juilland at the close of the course, and second, the entire Purdue staff met at length in January 1981 to evaluate the course and make recommendations to BLM for future offerings of this course. The evaluative comments and suggestions are listed below. Several of these arose as a result of student comments or suggestions and others more strongly reflect the feelings of the staff.

1. Schedule - keep the four-hour block for independent work, but add 1) a half-hour introduction to the IDIMS exercises each day before the independent-study period and 2) a brief discussion of the laboratory exercises immediately after this period. The four-hour block was used well by most of the students, however a discussion of the exercises would perhaps encourage more consciencious study. The staff is unanimous in believing that the four-hour block should remain in the middle of the day and not be shifted to the end of the day as some students suggested.

2. Balance - reduce the time allocated for Paul Anuta's presentation on enhancement and integration to allow more time for lectures and exercises on G-E-M resource models. The staff concurs that the theory supporting enhancement and data integration is important material for the students and must be included in the course, however a briefer, more visually oriented presentation would better serve the purpose of this course, with theory represented graphically rather than mathematically and interspersed with examples of applications in geologic studies. In general, the staff feels that more emphasis should be given to the presentation of enhancement techniques and uses than to considerations of data integration.

3. Use of IDIMS during lectures: the possibility of using a large-screen video projector to show the IDIMS screen to a group of students opens an interesting possibility for demonstrating an interactive enhancement and analysis system in a lecture format. For best effect, we feel that the person lecturing should also be the one to operate the terminal that brings up the images, but this would have required more experience with the IDIMS than the instructors for this course (with the exception of Donna Scholz) had had. Another prevailing concern among the instructors was that there were so many undependable aspects of system response time, image transmission, and image quality that they were relectant to plan on supporting their lectures wholly or even largely in this way.

4. Hands-on exercises: the ideal teaching environment for hands-on work would allow each participant to have extended if not complete access to a terminal and display station for the week. Once sharing of equipment becomes a necessity, compromises must be made. In our judgement, the availability of two terminals and one display was an absolute minimum for thirteen students. In fact had the other three registered students attended the course, the demands on the system and the schedule would have been extreme and would perhaps have reduced the effectiveness of these exercises for the other students. With the schedule we used, twelve students would be a more realistic maximum number, thereby removing the need for even one group of three. An alternative approach for BLM to consider would be offering a series of intensive courses giving students two-to-three days of more individual instruction. In such a format, the instructional team might be "in residence" for three weeks, with a new pair or trio of students arriving each day and following the same sequence of exercises and laboratories a day later than the pair ahead of them. It is recommended that if BLM continues hands-on instruction, the number of students be reduced or the number of analysis stations be increased. Although the objectives of the course were met in that the students had a solid introduction to what they could do on the system, it remains to be seen whether the amount of hands-on time was adequate to raise their interest or only caused discouragement about their ability to use the system in the future.

5. Student morale: student motivation in attending the course was mixed, and discussions indicated that some students saw little immediate possibility for using the technology and some others were attending at the wishes of someone other than themselves. The task of presenting a technology that is applicable to real work situations, as we believe remote sensing to be, lies with the instructors. Again, we would recommend, as we did at the conclusion of the first course, that one of the instructional team be a geologist from the BLM staff. This is the most efficient way of introducing examples from actual BLM projects into the course as illustrations of the concepts being presented.

   Another kind of incentive for more active participation would be to offer college credit for the courses. Approximately two credit hours of graduate credit could be offered to course participants, and those who chose this option could be assigned some additional work that would provide a means for the instructors to evaluate their progress. The work might include daily quizzes to help students assess their own understanding and a take-home exam that would require them to apply some of the key concepts presented during the course. Of course, other alternatives for evaluating student progress are possible.

6. Student notebooks: there was little indication that the glossary prepared for this course was used very heavily by the students. Although it was developed for this course as a result of student suggestions during the first course, we question that additional time should be spent in revising it for future courses.

Overall the student evaluations of the course were very positive, with ten of the eleven students who responded to question 9 saying that the course was "excellent" or "good" and only one ranking it as "fair." Unfortunately the student who gave it the low ranking made no other comments on the evaluation form to help us toward future revisions. The student comments were very helpful in pointing out both the strengths and weaknesses of the course, and the staff have used these comments to help guide their own. A detailed reading of Appendix F would be helpful for anyone who wishes to gain an understanding of the reception of the course.

VI. CONCLUSIONS

The course staff was pleased to have this opportunity to design a new course to meet the needs of BLM and to thus continue our association. Information about BLM and an appreciation of the students' actual work, gained during the first course, helped greatly during the planning for this course. We would welcome the opportunity to revise these two courses and to present them again for BLM in the coming year.

Appendix A

Remote Sensing for Mineral Specialists
Part II: Digital Techniques

Presented for: Bureau of Land Management, Denver
December 15-19, 1980

Presented by: Laboratory for Applications of Remote Sensing
Purdue University

General Course Objectives

The primary objectives of the course are to familiarize the participants with concepts basic to digital enhancement, overlay, and analysis of remote sensing data so that they can look upon this technology as another tool available to them in assessing mineral potential of federal lands. Participants will become familiar enough with the associated terminology to read, discuss, and evaluate these techniques knowledgeably, and, as for any tool, to become aware of the capabilities and the limitations of this technology and how it can be integrated with other tools. In addition, participants will have experience using the IDIMS system available to them in the Bureau and learn how they may use Bureau resources to aid them in future projects.

Specific Course Objectives

Upon completion of the course, students should be able to:

1. Recall the fundamental physical concepts involved in remote sensing, such as properties of electromagnetic radiation, the different portions of the spectrum, and the spectral behavior of earth surface materials.

2. Describe the basic digital processing steps involved in numerical analysis of multispectral remote sensing data, such as:

    a) converting numbers into images,
    b) training a computer-implemented classifier,
    c) selecting an appropriate classification algorithm
    d) displaying classification results in either pictorial or tabular formats
    e) interpreting and evaluating the classification results

3. Understand the principles and practices of image representation and manipulation on a computer-driven display screen.

4. Conduct interactive computer-aided analysis sequences based on the theory presented in the lectures.

5. Describe the basic enhancement operations (ratioing, contrast stretch, principal components, edge enhancement) in terms of elementary equations and understand the relative difficulty of performing each.

6. Give an example of the benefit of each of the enhancements in terms of a geological (or other) application.

7. Identify the basic requirements and steps in the data registration process.

8. Understand at least three basic data-type combinations and the benefits of digital analysis of these data.

9. Incorporate remote sensing data with other data, e.g. geologic or geophysical, in order to increase the detection of anomalous areas that may have geologic significance.

10. Develop models for mineral and/or energy resources based on significant, surface-observable data in order to improve resource evaluation.

Appendix B

Final Course Schedule (11/21/80)

Actual Course Schedule (12/19/80)

Dec. 15-19, 1980

Final Schedule for BLM Course II
(See course outline for details about topics to be treated)

Revised on 11/21/80

Times	Monday	Tuesday	Wednesday	Thursday	Friday
8-9	Review (1/3) LAB, SMD	Classification (3/8) LAB	Mid-Course Evaluation	Integration (2/6) PEA	Models (4/7) DWL
9-10	Review (2/3) LAB, SMD	Classification (4/8) LAB	Enhancement (3/8) PEA	Integration (3/6) PEA/DWL	Models (5/7) DWL
10-11	Data Processing (1/3) DKS	Classification (5/8) LAB	Enhancement (4/8) DWL, DKS	Models (1/7) DWL, DML	*Models (6/7) DKS, SMD
11-12	Review (3/3) LAB	Classification (6/8) LAB	Enhancement (5/8) PEA, DML	Integration (4/6) DML	Written Evaluation SMD
12-1	*Data Processing (2/3) DKS, SMD	*Classification (7/8) DKS, SMD	Enhancement (6/8) PEA, DML	*Integration (5/6) DKS, SMD	Lunch
1-2	Data Processing (3/3) LAB	Lunch	*Enhancement (7/8) DKS, SMD	Lunch	Models (7/7) DWL, DML
2-3	Lunch	Classification (8/8) LAB	Lunch	Models (2/7) DWL, DML	Wrap-up Staff
3-4	Classification (1/8) LAB	Enhancement (1/8) PEA	Enhancement (8/8) PEA	Integration (6/6) PEA	'BLM and remote sensing' J. Juilland et al.
4-5	Classification (2/8) LAB	Enhancement (2/8) PEA	Integration of Data (1/6) PEA	Models (3/7) DWL	*Exercise on IDIMS
evening		Optional Hands-on DKS, SMD		Optional Hands-on DKS, SMD	Boxes represent times set aside for individual work.

Dec. 15-19, 1980

Actual Schedule for BLM Course II
(See course outline for details about topics to be treated)

Revised on 12/19/80

Times	Monday	Tuesday	Wednesday	Thursday	Friday
8-9	Review (1/3) LAB, SMD	Classification (3/8) LAB	Mid-Course Evaluation	Integration (2/6) PEA	Models (4/7) DWL
9-10	Review (2/3) LAB, SMD	Classification (4/8) LAB	Enhancement (3/8) PEA	Integration (3/6) DWL	Models (5/7) DWL
10-11	Data Processing (1/3) DKS	Classification (5/8) LAB	Enhancement (4/8) DWL, DKS	Models (1/7) DWL, DML	*Models (6/7) DKS, SMD
11-12	Review (3/3) LAB	Classification (6/8) LAB	Enhancement (5/8) PEA, DML	Integration (4/6) DML	Written Evaluation SMD
12-1	*Data Processing (2/3) DKS, SMD	*Classification (7/8) DKS, SMD	Enhancement (6/8) PEA, DML	*Integration (5/6) DKS, SMD	Lunch Minicourses
1-2	Data Processing (3/3) LAB	Lunch	*Enhancement (7/8) DKS, SMD	Lunch	Models (7/7) DWL, DML
2-3	Lunch	Classification (8/8) LAB	Lunch	Integration (6/6 DKS, DML	Wrap-up Staff
3-4	Classification (1/8) LAB	Enhancement (1/8) PEA	Enhancement (8/8) PEA	Models (2/7) DWL	'BLM and remote sensing' J. Juilland et al.
4-5	Classification (2/8) LAB	Enhancement (2/8) PEA	Integration of Data (1/6) PEA	Models (3/7) DWL	
evening		Optional Hands-on DKS, SMD		Optional Hands-on DKS, SMD	

*Exercise on IDIMS

Boxes represent times set aside for individual work.

Appendix C. Registered Participants

List of Participants - Training Course 9100-11B

Remote Sensing for Mineral Specialists Part II

Kevin Andersen
BLM Royal Gorge Resource Area
831 Royal Gorge Blvd.
P.O. Box 1470
Canon City, CO 81212

Steve Barrell
BLM District Office
P.O. Box 119
Worland, WY 82401

Burrett Clay
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

Philippe DeHenaut
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

William DiPaolo
BLM Denver Service Center
Branch of Remote Sensing, D-234
Denver Federal Center, Bldg. 50
Denver, CO 80225

Roy Drew
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

David Eddy
BLM Battle Mountain -
Tonopah Resource Area: Bldg. 102
Old Radar Base
Tonopah, NV 89049

Helen M. Hankins
BLM Anchorage District Office
4700 East 72nd Ave.
Anchorage, AK 99507

John Kato
Fortymile Resource Area
P.O. Box 307
Tok, AK 99780

Mark P. Meyer
BLM Anchorage District Office
4700 East 72nd Ave.
Anchorage, AK 99507

Frances Pierce
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

Reginald Reid
63 Natoma Street
Folsom, CA 95630

Durga Rimal
BLM Oregon State Office
P.O. Box 2965
Portland, OR 97208

Mayo E. Ryder
BLM Ridgecrest Resource Area Office
1415 North Norma
P.O. Box 219
Ridgecrest, CA 93555

Wayne Stevens WO-520
Department of the Interior/BLM
18th & C Street NW
Washington, D.C. 20247

Richard Watson
BLM Northeast Resource Area
10200 West 44th Street
Wheat Ridge, CO 80033

November 17, 1980

Appendix D. Actual Participants

Final List of Participants - Training Course 9100-11B

Remote Sensing for Mineral Specialists Part II

Kevin Andersen
BLM Royal Gorge Resource Area
831 Royal Gorge Blvd.
P.O. Box 1470
Canon City, CO 81212

Steve Barrell
BLM District Office
P.O. Box 119
Worland, WY 82401

Philippe DeHenaut
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

William DiPaolo
BLM Denver Service Center
Branch of Remote Sensing, D-234
Denver Federal Center, Bldg. 50
Denver, CO 80225

Roy Drew
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

David Eddy
BLM Battle Mountain -
Tonopah Resource Area: Bldg. 102
Old Radar Base
Tonopah, NV 89049

Helen M. Hankins
BLM Anchorage District Office
4700 East 72nd Ave.
Anchorage, AK 99507

Frances Pierce
BLM Colorado State Office
Colorado State Bank Bldg.
1600 Broadway Blvd. Room 700
Denver, CO 80202

Durga Rimal
BLM Oregon State Office
P.O. Box 2965
Portland, OR 97208

Mayo E. Ryder (Gene)
BLM Ridgecrest Resource Area Office
1415 North Norma
P.O. Box 219
Ridgecrest, CA 93555

Wayne Stevens WO-520
Department of the Interior/BLM
18th & C Street NW
Washington, D.C. 20247

Andrew Tarshis
BLM Wyoming State Office
P.O. Box 1828
Cheyenne, WY 82001

Richard Watson
BLM Northeast Resource Area
10200 West 44th Street
Wheat Ridge, CO 80033

December 15, 1980

Appendix E.

Index to Videotapes

Tape Number	Period Included	Topics Included
1	Monday am*	Data processing (1/3) DKS Classification (1/8) LAB (con't)
2	Monday pm	Classification (1/8) LAB Classification (2/8) LAB
3	Tuesday am	Classification (3/8) LAB
4	Tuesday am	Classification (4/8) LAB (con't)
5	Tuesday am & pm	Classification (4/8) LAB Classification (8/8) LAB
6	Tuesday pm	Enhancement (1/8) PEA
7	Tuesday pm & Wednesday am	Enhancement (2/8) PEA Mid-course evaluation
8	Wednesday am	Enhancement (3/8) PEA (con't)
9	Wednesday am	Enhancement (3/8) Enhancement (4/8) DWL (con't)
10	Wednesday am & pm	Enhancement (4/8) DWL, DML Enhancement (8/8) PEA Integration (8/8) PEA (con't)
11	Wednesday pm & Thursday am	Integration (1/6) PEA Integration (2/6) PEA (con't)
12	Thursday am	Integration (2/6) PEA Integration (3/6) PEA, DWL (con't)
13	Thursday am	Integration (3/6) PEA, DWL Models (1/7) DWL, DML (con't)
14	Thursday am & Thursday pm	Models (1/7) DWL, DML Integration (6/6) PEA (con't)

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* Unexpected circumstances made it impossible for the camera man to arrive early enough to tape the opening two hours of the course.

15	Thursday pm	Integration (6/6) PEA Models (2/7) DWL Models (3/7) DWL
16	Friday am	Models (4/7) DWL Models (5/7) DWL (con't)
17	Friday am & pm	Models (5/7) DWL Wrap-up

Appendix F

Compilation of Course Evaluations

Remote Sensing for Mineral Specialists

Part II: Digital Techniques

December 1980

The thirteen students who completed the course were asked to fill out the attached written evaluation during the last day of the course. Eleven evaluations were returned, with promises that the other two would come soon. The responses on these eleven are compiled on the following pages.*

Following the course evaluation form is a copy of the General and Specific Course Objectives. These objectives are needed for responding to questions 3,4, and 5.

* The twelfth evaluation arrived later and is shown here as evaluation "L."

Course Evaluation

Remote Sensing for Mineral Specialists
Part II: Digital Techniques

December 1980

The instructors would appreciate your honest praise and/or criticism of the content, level, and presentation used in the course. Your comments will be of great benefit when the course is revised for presentation in the future.

1. What was the strongest aspect of the course?

2. What was the weakest aspect of the course?

3. To what extent did the course help you meet the stated objectives? (see list of course objectives)

Objectives	Completely	Mostly	Somewhat	Not at all
General Objectives	____	____	____	____
1	____	____	____	____
2	____	____	____	____
3	____	____	____	____
4	____	____	____	____
5	____	____	____	____
6	____	____	____	____
7	____	____	____	____
8	____	____	____	____
9	____	____	____	____
10	____	____	____	____

4. What activities or objectives should be added to the course to better meet the needs of the participants?

5. What activities or objectives should be deleted from the course? Please include your reasons.

6. List words you wish had been included in the glossary or ones you felt were inadequately defined.

7. Evaluate the new laboratory exercises by filling in the table below and commenting more fully below:

Title	Approx. time to complete	Errors?	As an instructional tool, would you rate it excellent, good, fair, or poor
a) Statistical Concepts			
b) Creating Pictures			
c) Numerical Analysis			
d) Enhancement			
e) Integration			
f) Models			
g) IDIMS Hands-on			

8. What changes would you suggest in the way the course was conducted?

9. Overall, how would you rate the course: (CIRCLE ONE)

   Excellent Good Adequate Fair Poor

10. Any additional comments or suggestions would be very helpful. Use the back of this sheet.

Remote Sensing for Mineral Specialists
Part II: Digital Techniques

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General Course Objectives

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Specific Course Objectives

Upon completion of the course, students should be able to:

1. Recall the fundamental physical concepts involved in remote sensing, such as properties of electromagnetic radiation, the different portions of the spectrum, and the spectral behavior of earth surface materials.

2. Describe the basic digital processing steps involved in numerical analysis of multispectral remote sensing data, such as:

   a) converting numbers into images,
   b) training a computer-implemented classifier,
   c) selecting an appropriate classification algorithm
   d) displaying classification results in either pictorial or tabular formats
   e) interpreting and evaluating the classification results

3. Understand the principles and practices of image representation and manipulation on a computer-driven display screen.

4. Conduct interactive computer-aided analysis sequences based on the theory presented in the lectures.

5. Describe the basic enhancement operations (ratioing, contrast stretch, principal components, edge enhancement) in terms of elementary equations and understand the relative difficulty of performing each.

6. Give an example of the benefit of each of the enhancements in terms of a geological (or other) application.

7. Identify the basic requirements and steps in the data registration process.

8. Understand at least three basic data-type combinations and the benefits of digital analysis of these data.

9. Incorporate remote sensing data with other data, e.g. geologic or geophysical, in order to increase the detection of anomalous areas that may have geologic significance.

10. Develop models for mineral and/or energy resources based on significant, surface-observable data in order to improve resource evaluation.

1. What was the strongest aspect of the course?

   A. The quality and quantity of visual aids, including slides, overheads, and especially handouts.
   B. Lab exercises- very good overview of functions; preparation by staff; good idea with the rotating lab, giving students about 3 hours during middle of day to review notes and catch up on exercises.
   C. (NR)*
   D. The application of the modeling system of geologic investigation to geologic exploration. The means of using the theory we received to actual mineral investigation.
   E. The uses and potential of enhancement, integration and modeling.
   F. Geologic models; hands-on experience with computer; was aimed specifically at its audience.
   G. Classification and models.
   H. Computer labs.
   I. Hands-on time - It seems the types of remote sensing data available are mind boggling. Being able to manipulate the various data was very helpful!
   J. There were several very strong aspects, particularly enhancement, integration and modelling. All were very good!
   K. Organization, knowledgeable instructors, good timing, good labs and hands-on sessions.

* NR = No Response

2. What was the weakest aspect of the course?

A. A few parts were too technical and mathematical.
B. Anuta - math, but his handouts and slides were a good idea! I think that is a good idea. Relate more to IDIMS. Edge enhancement was not clear. Bartolucci - LARS analysis - good but no need for that extent of work. Maybe output more related to IDIMS procedures.
C. (NR)*
D. The complicated theory involved in development of the enhancement and integration aspects of remote sensing.
E. The statistical methods used by the computer. We need to know what IDIMS can do for us - not how.
F. Anuta's presentations way too technical for our needs.
G. Labs, new tech, integration and enhancement
H. Theory of enhancement
I. Short time devoted to hands-on exercises.
J. The weak aspect was inordinately long time spent on preseing highly involved methematical formulas. These were mostly incomprehensible to me. Probably they could be part of the text but could have been lightly dealt in lectures.
K. It wasn't held in Honolulu! Not enough short breaks to facilitate concentration, especially after lunch. Too short; would liked to have had more time to absorb ideas, and to put them into effective practice.

* NR = No Response

3. To what extent did the course help you meet the stated objectives?

	Completely	Mostly	Somewhat		Not at all
General Objectives	2	4			
1	5	6			
3	1	9	1		
4	1	7	3		
5	1	4	4	1	1
6	2	6	3		
7	2	6	2	1	
8	3	6	2		
9	5	5	1		
10	5	6			
Total	30	66	17	2	1

Response from H: Mostly is A- to B+; "Completely" would have required more work on my part.

4. What activities or objectives should be added to the course to better meet the needs of the participants?

   A. (NR)*
   B. Relate to IDIMS capabilities and practical BLM geologist uses.
   C. (NR)*
   D. Possibly some more time on the actual use of this material in the field, and examples of previous use. It appeared that the most interesting portion of the course, models, received the least time.
   E. More examples of what to look for in images and how to enhance for a particular use.
   F. Much better than any other remote sensing course have ever taken because it addressed geology.
   G. More time.
   H. Simplified presentation of theory. More emphasis on uses of bands and ratios, particular applications *I;m sure I have most of this but a lot is lost in the mass) use of Prin. Components.
   I. Possible approaches to manual resource inventories.
   J. Don't think any thing should be added. The course is already heavy to adequately absorb in a week's time.
   K. More hands-on work. BLM needs a separate short course in geophysical methods for those who need it.

* NR = No Response

5. What activities or objectives should be deleted from the course? Please include your reasons.

A. (NR)*
B. All objectives seem applicable
C. (NR)*
D. The complicated mathematical portion should have the theory reduced and be theoretical approach replaced by a more layman approach, I felt this time was wasted because I retained nothing.
E. As stated above, certain computer functions could be explained in less detail.
F. Anuta's lectures - let someone else cover the material more simply.
G. (NR)*
H. Matrix algebra and its siblings
I. Mathematical aspects of enhancement - too technical
J. See comment 2 (use of highly involved mathematical formulas in lectures)
K. Delete most of theory of mathematical data for transforming images. Give in general terms with references for further reading, or give in a videotape session for any who are interested.

* NR = No Response

6. List words you wish had been included in the glossary or ones you felt were inadequately defined.

   A. (NR)*
   B. Sorry, didn't examine the glossary in detail.
   C. (NR)*
   D. (NR)*
   E. I found the glossary extremely helpful and adequate
   F. (NR)*
   G. (NR)*
   H. Didn't refer to it.
   I. (NR)*
   J. (NR)*
   K. Sea Sat, Thematic Mapper

* NR = No Response

7. Evaluate the new laboratory exercises by filling in the table below and commenting more fully below:

Approx. time to complete	1/2 hr.	45 min	1 hr	1hr.15min.	1 1/2hr	2 hr	3 hr	5hr	7hr
a) Statistical Concepts	4		2		1	1			
b) Creating Pictures	3	1	4			1			
c) Numerical Analysis									
d) Enhancement	3	2	2		2				
e) Integration	1	4	5						
f) Models		3	1		2		1		
g) IDIMS Hands-on			1	1				1	1
Total	11	10	15	1	5	2	1	1	1

As an instructional tool:	Excellent	Good	Fair	Poor
a) Statistical Concepts	1	7		
b) Creating Pictures	2	4	2	
c) Numerical Analysis				
d) Enhancement	4	3	1	
e) Integration	3	4	1	
f) Models	5	3		
g) IDIMS Hands-on	6	2		
Total	21	23	4	

Comments:

F. Section A - some of the problem explanations were a little vague - good otherwise
G. Section F - Did not complete; Section G - Not enough time
H. Section G - We had unfortunate problems with getting Bighorn stuff going and Shirley was not familiar enough with equipment to sort it out. I would like to see the labs a little longer (2 hrs) and done at the end of the day.
K. Section G - excellent, but too short

8. What changes would you suggest in the way the course was conducted?

   A. Change the enhancements and part of the integration sections so that it's not so technical and is less mathematical.
   B. More relationship to Branch of Remote Sensing projects & capabilities of IDIMS, i.e. Branch is using terrain data, geology, etc. Interest of students seemed to vary depending upon applicability to actual daily uses. Possibly after each segment or during, they should be reminded of actual "realistic" BLM application.
   C. (NR)*
   D. (NR)*
   E. The hands-on should be toward the end of the day and less rushed.
   F. Put the hands-on session at end of day to prevent dozing off and missing last 2 hrs. of lecture.
   G. Expand each segment to 2 weeks
   H. I believe Mr. Anuta & Mr. L'Heureux could have stayed home.
   I. Allot more time to IDIMS hands-on.
   J. (NR)*
   K. Have answers to the exercises and provide more references if someone feels they need to do more reading in a particular area.

* NR = No Response

9. Overall, how would you rate the course:

	Excellent	E/G	Good	Adequate	Fair	Poor
A.			X			
B.	X					
C.					X	
D.			X			
E.			X			
F.		X				
G.		X				
H.			X			
I.			X			
J.	X					
K.	X					
Total	3	2	5	0	1	0

Comments:

B. You can tell hard work & preparation went into this.

10. Any additional comments or suggestions would be very helpful.

A. RE: the four hour lab time and the exercises (except hands-on) - the "answers" should be provided with the exercise; since some people weren't doing the exercises, it might be better just to let people do them on their own time and have canned videotape or slide presentations instead for that part of the four-hour slot. RE: Course materials, handouts, etc. - all materials should be given to the participants ahead of time so that they can read or at least go over it before the course starts.

B. Paul could relate his material to what the Branch was actually doing to make it more interesting such as integration etc. Maybe next time Advent Screen can be hooked up directly with the cable for a better picture. A review or brief discussion was needed after each exercise to clarify and answer questions.

C. Tuesday comment - The course was titled "Remote Sensing for Mineral Specialists" but it seemed that it should have been titled "Remote Sensing for Range Cons and Foresters." If corn, soybeans, deciduous forest, and coniferous forest are the only examples that can be used to explain the digital techniques, then I suggest that the state of the art for digital classification for geologic investigations is not far enough advanced for BLM geologists to be spending a week learning "the basics". I feel that this time and money could be better spend on Messrs. DiPaulo, Juilland and others to continue to develop and refine models for geologic applications that are useful for minerals management by BLM. I would like to see what the minerals industry is doing with digital classification for their exploration programs. Should these techniques become useful to field geologists through Bureau research (which I think is important, regardless of what results are generated) then I think that, rather than a week of training, the use of the system can be taught to individual geologists working on their individual projects in conjunction with the remote sensing specialists. In this way only the techniques and manipulations necessary for the particular project will be learned instead of cluttering our minds with theory, statistics, and math that we will forget this weekend anyway. So far we have only been shown possibilities that mineral specialists may use in the future. When something useable is developed, then training for these specific uses would be valuable. Friday comment - DWL's part of the course has significantly raised my opinion of the utility of this course to BLM geologists. Of course, the models, which are the end product of all the foregoing, is the most interesting and useful for our work. I feel that the beginning of the course (Data Processing, Classification and Enhancement) could have been much compressed. I feel that the overall course emphasized Landsat and digital manipulation too much at the expense of how the models are developed and hands-on time working with the models. This runs counter to the weekly held philosophy among academics that the detailed basics are necessary to the understanding of the entire system - I disagree. Computer operators (most) do not know how to repair a computer - neither do geologists need to know everything about digital manipulation nor can it be learned and retained in a week. Computer repair is left up to computer repairmen; digital processing should be left to those knowledgeable in it to assist specialists in all fields, not just geology, to generate and use models. Hopefully, Jean Juilland will give in his closing remarks how we as geologists can set up funding within our respective offices to use what we've learned for mineral inventories.

D. (NR)*

E. (NR)*

F. (NR)*

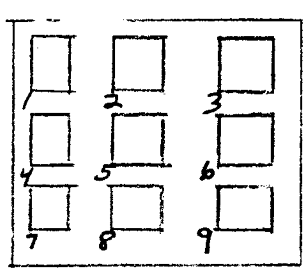
G. Luis did an excellent job. Don did an excellent job. Paul's lecture techniques need improvement. Well prepared, but lasks techniques. I had a soil physics prof. who packed them in and also presented extremely technical data. It can be done.

H. Shirley & Donna obviously work hard and take their responsibilities very seriously. Luis also tries hard and is mostly successful. He tries hard to answer (and understand) questions. Don L. is very good although he just cannot cover so much ground and so is losing a lot. Under the circumstances it's very good. Some of the others did not seem able to relate to our needs and backgrounds. Could not understand questions. Absolute waste of time.

I. (NR)*

J. Whenever possible ask the participants (and in most cases help them) to bring geochem & geophysical informations from their areas. Allow them, where appropriate, to work their problems, at evenings, if necessary.

K. Would like to see a brief discussion of disadvantages to be overcome in Landsat interpret for geol, such as vegetation. Would like to see fewer examples of corn and soybeans and more of rocks. More time should be spent on geologic models & their development. I would like to have one or two photos of several images which show different effects:



1. Landsat Color Composite
2. Band 4
3. Band 5
4. Band 6
5. Band 7
6. Edge Enhancement
7. Direct Filter
8. Model - Integration
9. Psuedo-color

L. Overall impression of the teaching staff:

Coordinator - Shirley Davis - Crisp style from first part of the course is still there. Her benign control of the class schedule was very much in evidence. The organization of the course, amended from the first session, was made more effective by Ms. Davis's ability to direct the pattern of information presentation. I noticed an improvement in an organizational situation from the last session reflected in a lack of any disorganization by staff or students; all knew where he or she was to be at every moment. Support materials were well tailored to sessions and all available within adequate time in the schedule.

Bartolucci - Extremely capable, relaxed, and has the gift of charisma. Luis was almost able to produce a miracle--present three days worth of complex material to the class in two days. I say almost because his exercises and discussions on classification deserved more classroom time. I was intrigued and amazed by how much extra work in preparation Luis must have devoted to have generated his beautiful computer printouts. I was inspired by these examples to extra work during the available evening terminal sessions to develop a mini-classification scheme. I am looking forward to reviewing Luis's printouts in the future, and consider them invaluable. Luis gave me a reference entitled "Natural Resource Mapping in Mountainous Terrain by Computer Analysis of ERTS-1 Satellite Data" LARS Information note 061575, which I have reviewed, and believe should be added to the list of pre-course readings. Luis's responses to class questions were quick, germaine to the issue, and always informative; he rarely had to repeat a point in subsequent lecture. Luis's use of illustrations (blackboard or slide) amplified his subject. I must confess that despite how much I was interested in his presentations on both Monday and Tuesday, I needed an additional break in the late afternoons to maintain my concentration. I believe this "saturation point" was reached because of the "3 days worth of work in 2" paradox he faced. Still I think he nearly carried it off.

Scholz - Donna must be a very "quick study." She has overcome the problem of nervousness which I noted in the first course. Her presentations were relaxed, informative, and maintained the high degree of rapport noted before. Her confidence was an aura about her. Her control of the class was marvelous and her lectures the same. It was only in the terminal "hands-on" sessions that I noticed she lapsed into the tendence to "rush statements." Donna and Shirley are to be commended for the "double duty" on the terminal sessions. I am a chauvanist of the old school and found it an uncomfortable feeling to know that I was preventing them from getting lunch. In the evenings I was overjoyed to have the opportunity to work on individual projects with Donna available for bailing me out of bottlenecks. Critically, I can say that she answered all my questions at the terminal although several times I was getting very jealous of her need to work on the next day's "hands-on" program. Was this need because the system was still being tested out? or a necessity which could not be avoided. The reason I bring this up is that this time very few people took advantage of the evening sessions; next time Donna and Shirley may have more people. With more people Donna's absence might produce frustration and defeat the purpose of the "extra" evening hands-on. Donna is an invaluable part of the course team.

Anuta - Paul has a great deal of potential. He appears sensitive, knowledgable, and possesses the abilities to capture an audience. That he did not do so this session can be attributed to "poor packaging", not to a lack of individual ability or enthusiasm. First either give Paul an attached microphone or mute the slide projector. Personally I would give him a mike; he unconsciously tends to trail off his sentences. Next distribute the 36 page image enhancement handout to the class at least 1 day in advance of Paul's lecture. At the mid-course evaluation Shirley questioned the professionalism of future classes by stating that she did not feel we would read these handouts. Remote Sensing Training is an official assignment and not a vacation; until demonstrated otherwise let us assume it will be treated as a professional assignment. Give out the handouts early. Allow Paul to augment knowledge on two levels in class: by using slides and amplifying key words and concepts by lecture. From personal experience in giving a number of professional slide presentations I would recommend tinting the slides in pastel shades of blue and tan.

This reduces the glare produced by black on white slides. It also improves the ability of the individual to concentrate on a long series of slides. Because the nature of Paul's subject matter leads the observer to consider comparing various enhancement techniques, a 2 projector side-by-side slide comparisons spaced throughout the lecture will guarantee that everybody is on their toes. Professional speaking is a little like boxing: you have to vary your packing: jab, feint, go for uppercut. Anyone of these "paces" used in excess and you end up on the canvas looking up at stars.

L'Heureux - Capable, informative. Admirably filled the role in the mid-day block system of instructor available to answer questions on class exercises. Always presented answers in both one-on-one and instructor-class situations clearly using easy-to-understand examples. Excellent classroom control; high marks for audience rapport. Struck correct balance between handouts, slides, lecture, and exercises. At infrequent times moved too fast in covering a particular subject. The subjects Dave developed in his lectures have not tapped his full potential for the course; I have a distinct impression there is much more that he could offer.

Levandowski - Effective, engaging speaker who is no longer suffering from any disorientation. Slides, lecture, handouts, and exercises are perfectly coordinated. Here and there he hurried through sections of his lecture, and I could swear that some of his overhead transparancies had wings, but he never lost me. The charisma caused me to switch my mind and hand to high gear. It's a damn shame I never had an instructor in grad school who was in "peak form," as Levi obviously is all the time. Levi also actied as a classroom resource during black-time, and was quick to answer any questions that arose. Levi was outstanding.

Exercises on the IDMS terminal - Excellent. The exercises have been well thoughtout, considerable work went on in their preparation. The instructions were clear, and the handouts valuable. The time set aside on the terminal is adequate in order for the student to get an appreciation of the potential of IDMS as a tool. Programs were remarkably free of bugs.

Structure of mid-day workshop - The creation of a time period in the middle of the day where the student can do some self-paced learning is magnificent. I don't know if the system was designed this way or grew out of an enforced necessity to limit number of people on the terminal. No matter KEEP IT, KEEP IT, KEEP IT. Fill the non-terminal time just as you did this time with video cassetts, graphing exercises, and one-on-one instruction, as well as resource reading time. Absolutely fantastic idea. I feel it was the ideal classroom mode to introduce students to material. Unfortunately the instructors had to sacrifice lunch, which makes for unhappy feelings by the time the last group gets on the computer.