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Final Report

**REGIONAL SEMINAR ON REMOTE SENSING
TECHNIQUES, LIMA, PERU, 7-18 AUGUST 1978**

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Applications Division

NOVEMBER 1978

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16. Abstract A Regional Seminar on Remote Sensing Techniques was held in Lima, Peru from 7-18 August 1978. The Environmental Research Institute of Michigan conducted the seminar under sponsorship of AID. Objectives of the seminar were to introduce government officials to remote sensing technology through a series of lectures and to give them practical experience in the use of remote sensing data products by means of discipline-oriented workshops. A team of four U. S. scientists, representing applications disciplines of vegetation, geology, and oceanography/hydrology were involved in preparation and presentation of the seminar. Lecture topics and workshop activities are presented.					
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PREFACE

This report documents the preparations and activities associated with the Regional Seminar on Remote Sensing Techniques held in Lima, Peru between August 7-18, 1978. The seminar was conducted by the Environmental Research Institute of Michigan (ERIM) under sponsorship of the U. S. Agency for International Development.

The success of this seminar was due in large measure to the cooperation of Peruvian and AID/Lima Mission personnel. The planning and assistance provided by Dr. Carlos Calderon and other members of the Seminar Coordinating Committee is especially acknowledged. In addition, notable contributions to the Seminar were made through the generous use of the Andean Pact Building by Dr. Jesus Alberto Fernandez, the ONERN facilities by Ing. Jose Lizanoga Reyes, and the INGEOMIN facilities by Ing. Benjamin Morales Arnao. AID/Lima Mission personnel particularly helpful in arranging the Seminar included Mr. Leonard Yaeger, Director, and Ing. Edilberto Alarcon.

Project PERCEP personnel, Dr. Jose Pomalaza and Mr. William Bruce, in Ottawa, Canada, are also acknowledged for their cooperation in providing readily-available Landsat digital tapes to ERIM.

Several ERIM personnel deserve recognition for their efforts in the preparation for the Seminar. They include Ms. Jacquelyn Ott (slide and materials preparation), Larry Reed and Jim Balcerski (computer-enhanced Landsat images), Ms. Nancy Moon (typing), and Jim Cooper (syllabus publication). Mr. Sergio Camacho was most helpful in translating the syllabus into Spanish.

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SUMMARY AND RECOMMENDATIONS

The Regional Seminar on Remote Sensing Techniques was held in Lima, Peru between August 7-18, 1978. The focus of the seminar was to introduce government officials to remote sensing technology through lectures and to give them practical experience in the use of remote sensing data products through a series of discipline-oriented workshops.

Approximately 180 government officials from Peru, Paraguay and Ecuador attended the first week lectures. The audience was dominated by Peruvians. Attendance at each of the three second week seminars (covering vegetation, geology, and hydrology/oceanography) was limited to approximately 20 persons per workshop by logistical constraints.

By any measure, the seminar was successful. The participants were enthusiastic during and after the seminar. In the workshop sessions many government personnel learned about and worked with remote sensing data available in Peru about which they had no prior knowledge. Logistical arrangements were well done though not without some anxious moments. Press coverage was excellent -- there was a television interview and three press interviews during the two week seminar. Over half the seminar participants requested additional information which was sent to them after the four man team returned to the States.

1.1 HISTORICAL DEVELOPMENTS LEADING TO THE SEMINAR

Sometime in 1977, representatives of USGS visiting Peru were informally asked about the possibility of a seminar on remote sensing technology for Peruvian government officials. This led to a formal request from the Peruvian agency CONIDA (Comision Nacional de Investigacion y Desarrollo Aeroespacial) through the AID mission in Lima that a seminar be held in mid-1978. USGS indicated that prior commitments precluded its participation in a seminar in mid-1978. At that time, representatives of AID/OST asked the Environmental Research Institute

of Michigan (ERIM) if they would be willing to execute such a seminar -- we agreed.

Preliminary plans for the seminar were for a three to four week session focussed on digital processing techniques. However, since the desires of the Peruvians had been obtained only from cable traffic between Lima and Washington, it was recognized that a visit to Lima would be needed to get a more precise estimate of Peruvian desires. In addition, participation of other countries needed to be arranged since AID/OST had insisted on a broadening of attendance from the strictly Peruvian initial request to a regional scope as a condition of support.

In May, 1978, an ERIM representative visited Lima to harden arrangements for the seminar. There were two important results of this visit. One was that the content of the symposium was broadened from a treatment of digital processing to the analysis of various forms of remote sensing data. The second was that the desire of AID/OST for a truly regional symposium was made clear to the Peruvians. The latter resulted in a cabled invitation from AID/Lima to all South and Central American countries to send representatives to the August seminar. The former resulted in the development of a series of lectures covering Geology, Vegetation, and Hydrology/Oceanography (topics of Peruvian interest) and dealing with manual and machine analysis of satellite and aircraft imagery, synthetic radar data, and meteorological satellite imagery. To carry out the week of lectures and to help supervise the second week workshops, ERIM retained Dr. Vytautas Klemas and Mr. William Smith as consultants in oceanography and geology, respectively.

Although other South and Central American missions were given about two months notice of the seminar, the attendance from other countries was disappointing. There was one attendee from Ecuador and from Paraguay. There was initial interest shown from representatives in El Salvador and Venezuela, but these attendees later cancelled plans to attend because of schedule conflicts. We feel that two months is

probably inadequate lead time for notification and for response from potential attendees from other countries. There was strong desire to have the seminar in August to avoid conflict with another remote sensing seminar scheduled in Lima for November.

1.2 SUMMARY OF SEMINAR PROGRAM

1.2.1 PREPARATIONS

After the visit in May, ERIM began preparing the lectures and workshop exercises for the seminar. An agenda for the lectures was prepared and transmitted to Peru for concurrence of the steering committee. Because of slow mail delivery, concurrence was late in coming, but was eventually received. ERIM preparations consisted of assembling the necessary slides and Landsat data for lectures and workshop demonstrations, securing the services of two consultants to assist in geology and oceanography, and the preparation of copies of a Spanish language seminar syllabus which was given to each seminar participant. The steering committee arranged for auditoriums and working space for the lectures and workshops, for slide projection and TA equipment, and for translation of the lectures from English into Spanish. Plans for simultaneous translation were abandoned because of cost and lack of a suitable facility in Lima.

1.2.2 LECTURERS

Four lecturers presented material during the first week. Mr. Frederick Thomson presented material on remote sensing hardware basic concepts, and digital processing. Mr. Franklin Sadowski lectured on manual interpretation and applications in vegetation mapping. Dr. Kiemas, from the University of Delaware, lectured on meteorological satellite sensors and applications in hydrology and oceanography. Mr. William Smith of Spectral Data Corporation lectured on geologic applications of remote sensing.

During the second week, Mr. Sadowski conducted the workshop on vegetation applications. Dr. Klemas conducted the workshop on hydrology/oceanography applications. Both of these workshops were held at ONERN (Oficina Nacional de Evaluacion de Recursos Naturales). Mr. Smith and Mr. Thomson conducted the Geology workshop at INGEOMIN (Instituto de Geologia y Minería).

1.2.3 CONDUCT OF THE FIRST WEEK ACTIVITIES

The first week activities were conducted in the Andean Pact building (Acuerdo de Cartagena) in downtown Lima. The first week began with an opening ceremony featuring the Minister of Aeronautics, the Director of the Andean Pact, the AID Mission Director, and other speakers. After the opening ceremonies, the seminar moved to a larger auditorium where there were speeches by representatives of three Peruvian agencies already involved in remote sensing. Monday afternoon, the lectures began. They ran through Friday afternoon. Table 1 shows the lecture topics and speakers.

1.2.4 CONDUCT OF THE SECOND WEEK ACTIVITIES

During the second week, workshops were held at two locations. The hydrology/oceanography and vegetation workshops were held at ONERN. The geology workshop was held at INGEOMIN. Whereas the first week concentrated on lectures, the second week concentrated on practical experience in interpretation of Landsat, SLAR, and aerial photography.

The vegetation workshop dealt with the use of Peruvian Landsat coverage and aerial photography for several of the irrigated agriculture river valleys to perform multistage agricultural inventories of these valleys. A second topic was the assessment of tropical forestry communities using computer processed Landsat and visually interpreted SLAR data. The geology workshop dealt with mapping of regional structure and geomorphology from Landsat and SLAR images. The hydrology/oceanography dealt with three topics of interest to the diverse audience --

TABLE 1
PERU SEMINAR TOPICS AND SPEAKERS

Regional and National Centers and Programs - Thomson
Overview of Remote Sensing Systems - Thomson
Basic Concepts of Remote Sensing - Thomson
Review of Photographic and MSS Remote Sensing - Sadowski
Landsat Imagery Analysis - Sadowski
Landsat Digital Analysis - Thomson
Landsat Vegetation Analysis - Sadowski
Landsat Oceanography Analysis - Klemas
Basic Thermal Sensing - Thomson
Applications of Thermal Sensing - Thomson, Sadowski
Landsat Geometric Correction - Thomson
Meteorological Satellite Sensors - Klemas
Meteorological Satellite Applications in Oceanography - Klemas
SLAR Sensors - Thomson
SLAR Applications to Oceanography and Vegetation - Klemas, Sadowski
SLAR Applications in Geology - Thomson, Smith
Landsat Applications in Geology - Smith
Hydrological Applications - Klemas
Present and Future Landsat Systems - Thomson

mapping coastal upwellings with multitemporal thermal data from meteorological satellites, the possibility of mapping rainfall intensity and cloud moisture content using cloud albedo and cloudtop temperature as sensed from meteorological satellites, and delineation of watershed extent, land use, and other hydrologic parameters from Landsat data.

1.3 CONCLUSIONS AND RECOMMENDATIONS

From all indications the seminar was highly successful. Advance planning on the parts of ERIM, AID Mission, and CONIDA personnel aptly coordinated the program and provided for adequate facilities, materials, and essential equipment. Specific conclusions and recommendations are noted as follows:

- . Interest and enthusiasm of the participants was exceptional. Many individuals made valuable contributions to the workshops through voluntary presentations of pertinent subject material. Group discussions were lively and informative. There was great interest by participants for receiving more information from ERIM team members and for continuing associations with ERIM team members by correspondence.
- . Significant inter-agency cooperation and ties may have been initiated as a result of the seminar. At the encouragement of ERIM team members, participants from different agencies helped to furnish information and materials for the success of the seminar. More importantly, the seminar provided the circumstance in which many participants realized a need for common data and information parameters to accomplish their duties despite their association with different agencies.
- . Use of Landsat and other remote sensing data products acquired over Peru was valuable for the workshop sessions. In addition, the computer-enhanced Landsat images were particularly important

for structuring many of the workshop activities. Although acquisition and processing of such data on short notice necessitated quick reaction at ERIM prior to the seminar, the effort served to assure maximum participant interest in workshop sessions. Moreover, computer-enhanced Landsat images should continue to be useful in the future in Peru. For future seminars, we recommend that greater lead time be allocated for acquiring data products and constructing exercises that are appropriate for the particular country or region.

- Lecture outlines and visual aids prepared for this seminar by the ERIM team members now represent a set of materials that will be useful for future seminars.
- Acquisition of remote sensing data products was identified as somewhat of a problem in Peru. Acquisition of Landsat coverage of Peru through the EROS Data Center entails reliance on the tape recorder on board Landsat - the tape recorders have been subject to malfunction at times. Although real-time transmission of Peruvian Landsat coverage is collected by the Brazilian receiving station, many Peruvians were not completely aware of this fact. Others expressed difficulty in obtaining data from the Brazilians. For meteorological satellite data, Peru has no active reception capabilities. However, it is our feeling that by upgrading the existing facility at Ancon, met-sat data reception could be provided.
- The ultimate success of the seminar/workshops will be shown by the degree to which the participants have been stimulated to pursue the application of remote sensing data to their projects and to the extent the Peruvian agencies encourage the acquisition of imagery and enhancement equipment and promote further investigations in the applications of data. The immediate response was most encouraging.

SEMINAR DETAILS

2.1 PREPARATIONS

2.1.1 ADVANCE COORDINATION

Following ERIM's receipt of the request from AID/Washington to conduct a regional remote sensing seminar in Peru, Mr. Frederick Thomson travelled to Lima in early May to discuss seminar content with appropriate Peruvian agencies and AID/Lima, to arrange seminar logistical requirements, and to identify sources of supporting remote sensing data (SLAR imagery, aerial photography).

During the one week visit in Lima, Mr. Thomson visited seven Peruvian agencies using or wanting to use remote sensing, and had several discussions with the coordinating committee of the Regional seminar. The coordinating committee, headed by representatives of CONIDA (Commission Nacional de Investigacion y Desarrollo Aeroespacial), had representatives from the other six Peruvian agencies.

During the visit, the Peruvians were made aware that regional participation would be a necessary condition for support of the seminar by AID/Washington. The original concept had been to have a seminar for Peruvians only. The requirement for regional participation led to an announcement of the seminar (which was distributed through AID/Washington) and a cable from the AID/Lima mission to all other South and Central American AID missions announcing the seminar. The distribution of the announcement occurred about two months prior to the seminar.

It was agreed in meetings with a seminar steering committee that the committee would be responsible for publication of announcements, registration of participants, securing meeting rooms and visual aid equipment, translation from English into Spanish, and for logistics of coffee breaks, etc. ERIM would be responsible for the development of a seminar curriculum (to be approved by the steering committee), printing a Spanish language syllabus for each seminar participant, and for

organizing details of the workshops for the second week. A general seminar outline was agreed to with the first week consisting of lectures on Landsat, SLAR, and meteorological satellite sensors and data interpretation, followed by a week of discipline specific workshops in geology, hydrology/oceanography, and vegetation. During the workshops, participants were to be given hands-on experience interpreting various data products over areas of interest. To help in focusing on current project areas, each agency was asked to specify the coordinates of test areas for demonstration projects.

2.1.2 MAY-AUGUST ACTIVITIES

During the May-August time frame, preparation for the seminar were conducted at ERIM and in Lima. A set of topics for the first week lectures were formulated by ERIM in response to the desires expressed by the coordinating committee. By mutual agreement the scope of the symposium was broadened from the concept of a digital processing seminar to a seminar emphasizing the uses of a variety of remote sensing data. Special attention was given to interpretation of the aerial photography, SLAR imagery, and Landsat data already available or easily obtained by South Americans.

Attempts were made to acquire Landsat data for the test areas identified by the steering committee. The hope was to acquire digital tapes of relatively cloud free scenes covering the areas of interest so that contrast enhanced color infrared 1:250,000 scale prints could be prepared on ERIM's Earth Resources Data Center facilities. Through judicious selection of tapes already on file at the EROS Data Center and the cooperation of the PERCEP project personnel (especially Jose Pomalaza and Bill Bruce) in Ottawa, Canada, tapes of scenes around Cajamarca in northern Peru, Pisco in the central coastal area, and Puno in the southeast near Lake Titicaca were obtained. Imagery of the Huancayo area was obtained from the EROS Data Center for interpretation by geologists interested in uranium resources.

Slides illustrating pertinent points for the lectures (detailed in Table 1) were assembled from the ERIM collection and those of the two consultants; William Smith (Geology) and Dr. Vytautas Klemas (Hydrology/Oceanography). Some slides were specially prepared in the ERIM photo lab for these presentations.

The seminar lectures prepared course outlines (syllabi) for the topics outlined in Table 1. The syllabi, along with biographical sketches of the lecturers and schedule information were translated to Spanish by a University of Michigan graduate student in remote sensing, insuring an accurate translation not only of common language but special technical phrases. The syllabi were then printed at ERIM, assembled in looseleaf notebooks (to facilitate note-taking) and hand-carried to Peru.

While this activity was going on, communications between ERIM and Peru were established by letter (and later by much more reliable telephone call). Approval of the steering committee for the content of the lectures was secured. Arrangements were made for meeting places for the first and second weeks activities. The mundane requirements for projection equipment, translators, and display facilities were communicated and agreed to.

A particular concern was the lack of response from the other Central and South American countries, especially those of the Andean Pact (Bolivia, Colombia, Ecuador, and Venezuela). In the end, we had one attendee from Ecuador and one from Paraguay. There were responses from El Salvador and Venezuela, but people from these countries cancelled before the commencement of the seminar. In retrospect, the major reason for the lack of response was the short two month interval between the announcement and the seminar. That was insufficient time for the seminar notice to be distributed to interested personnel in the pertinent government agencies. This seminar had been scheduled with only three month lead time to avoid conflict with another Peruvian remote sensing symposium to be held in November. In the future, it would be wise to have four or five months preparation time, for a regional seminar of this size.

2.1.3 PRE-SEMINAR VISIT

Two working days prior to the seminar, Mr. Thomson travelled to Lima in order to coordinate final arrangements. There was considerable activity on these two days that continued into the weekend. In particular, last minute requirements for 120 additional syllabus copies were identified as a result of the increased first week lecture attendance from 60 to 180. Requirements for spare bulbs for projectors were also identified. The syllabi and spare bulbs were hand carried by Mr. Sadowski, who arrived on the Saturday before the symposium.

Also, arrangements for meeting rooms and translators were reviewed. We had hoped to have simultaneous translation of the English lectures into Spanish. As it turned out, this was not possible because of a lack of appropriate facilities and cost of translators. (The translators were to be provided by the Peruvians.) As a backup, delayed (sentence-by-sentence) translation by bilingual Peruvian agency personnel provided an acceptable alternative.

On Saturday morning there was a television interview with members of the steering committee and Mr. Thomson. The interview was aired during the following week.

The arrival of ERIM team members in Lima over the weekend helped expedite the many final preparations for the seminar. A lot of details were worked out which probably should have been resolved much earlier. Part of this is undoubtedly due to the lack of experience in setting up seminars on the part of the Peruvians. As a result of our efforts, however, logistics were reasonably well in place for Monday morning.

2.2 FIRST WEEK ACTIVITIES (August 7-11)

Seminar activities during the first week consisted principally of lectures illustrated with 35 mm slides. An opening ceremony and round-table discussion was held on Monday morning, and a panel discussion concluded the week on Friday afternoon. All activities were conducted in the Andean Pact Building in Lima.

2.2.1 OPENING MORNING

To begin the seminar, the first half-day was devoted to an opening ceremony and a roundtable discussion. Opening ceremony participants included representatives of the major coordinating bodies for the seminar. These people included:

Major Gen. Jose Aste Seminarlo - President of CONIDA

Dr. Jesus Alberto Fernandez - Coordinator of the Andean Pact

Mr. Leonard Yaeger - AID Mission Director

Mr. Frederick Thomson - ERIM

Gen. Jorge Tamayo de la Flor - Minister of Aeronautics

Each made a short statement. The ceremony was conducted in a small amphitheatre-like meeting room that allowed approximately one-half of the seminar participants to attend. Television and press covered the opening ceremony.

Following the ceremony, all moved to a large meeting room for the roundtable discussion. The discussion was led-off by a 30 minute presentation on regional and national centers and programs in remote sensing delivered by Mr. Thomson of ERIM. Representatives of Peruvian Agencies then made short presentations about the involvement and needs of their organizations for remote sensing activities. Representatives included:

Ing. Alberto Giesecke Matto - Chief of IGP

Ing. Jose Lizarraga Reyes - Director of ONERN

Ing. Benjamin Morales Arnao - Director of the Geological and Mineral Institute

A large number of questions and comments from the seminar participants followed. Many addressed the issue of a regional center in Lima. Although not all comments made by the audience were translated into English.

it was clear that the discussion was a lively one with varied opinions about the organization and responsibilities of such a center. The discussion lasted an hour and a half past the allotted time and was deemed very successful.

2.2.2 LECTURES

Lecture presentations dominated the activities of the first week. All were illustrated with 35 mm slides. All were delivered in English with delayed translation into Spanish provided by knowledgeable Peruvian scientists. The delayed translation procedure was somewhat awkward on a few occasions, requiring the speaker and/or interpreter to rephrase and repeat particular concepts. However, such repetition likely served a good purpose by reinforcing the point at hand. In general, we were very pleased with the level of technical understanding demonstrated by the interpreters and their capabilities to rapidly translate concepts into Spanish.

All four members of the ERIM team had the responsibility for developing and delivering several lectures. The schedule of lectures delivered during the week is illustrated in Table 2. An opportunity was provided after each lecture for questions.

At the conclusion of the first week, a panel discussion brought all four members of the ERIM team together in front of the participants on Friday afternoon. With the assistance of interpreters, participants addressed questions to appropriate speakers. Many of the questions illustrated good comprehension of technical material presented during the week. The session lasted for about 2-1/2 hours.

2.2.3 PRESS COVERAGE

In addition to press coverage of the opening ceremonies, there was also a press conference during the lecture week. Representatives of La Prensa, a major Lima newspaper, interviewed all seminar lecturers and

TABLE 2. LECTURE SCHEDULE PRESENTED DURING FIRST WEEK OF SEMINAR

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
0800	Registration				
0900	Opening Ceremonies	Landsat Imagery Analysis	Basic Thermal Sensing	SLAR Sensors	Hydrologic Applications
1000	Regional and National Centers and Programs		Applications of Thermal Sensing		SLAR Oceanography and Vegetation
1100	Uses of RS in Andean Pact Cos. (Panel Discussion)	Landsat Digital Analysis	Landsat Geometric Corrections		
1200	Lunch		Lunch	Lunch	Lunch
1300		Lunch	Lunch		
1400	Overview of Remote Sensing Systems	Landsat Vegetation Analysis	Meteorological Satellite Sensors	SLAR Applications in Geology	Question and Answer
1500	Basic Concepts of Remote Sensing	Landsat Oceanography Analysis	Meteorological Satellite Applications in Oceanography	Landsat Applications in Geology	
1600	Review of Photographic and MSS Remote Sensing			Adjourn	Adjourn
1700	Adjourn	Adjourn			Adjourn

several of the seminar participants. La Prensa had planned a feature article on the seminar for their Sunday magazine. The coverage was due for the Sunday after we left Lima - August 27.

2.3 SECOND WEEK ACTIVITIES (August 14-18)

During the second week, workshops in vegetation, hydrology/oceanography, and geology were held. These workshops, each attended by about 20 participants, offered an opportunity for hands-on interpretation of Landsat and other remote sensing products. Because of the predominantly Peruvian attendance at the workshops, examples of imagery and data used for interpretation covered areas within Peru.

2.3.1 SUMMARY OF ACTIVITIES FOR THE VEGETATION WORKSHOP (F. Sadowski)

The vegetation workshop was held at ONERN where facilities and equipment were provided through the cooperation of Ing. Lizarraga, Director General. Some 20 participants from approximately 8 Peruvian agencies and one Paraguayan agency attended (see Appendix B). Interests ranged from land use to agriculture to forestry.

Enlarged computer-enhanced color-composite Landsat frames of four different areas in Peru provided the basis for much of the workshop activity. These frames covered areas as follows:

Frame 1379-14521, 6 August 1973, Cajamarca area -- mountainous terrain with agriculture in river valleys leading to the coast

Frame 1664-14304, 18 May 1974, Ica river valley -- major agricultural region

Frame 1502-14320, 7 December 1973, Iquitos area -- Aguaje Palm and associated low jungle forest communities

Frame 2154-14132, 25 June 1975, Puerto Breu area -- high jungle forest area

Map and air photo coverage for agricultural areas in river valleys on the Cajamarca frame (Rio Chancay-La Leche) and the Ica frame (Rio Ica) was

acquired and utilized with the Landsat images. Limited air photo coverage was available for use with the Iquitos frame and SLAR coverage was available for comparison with the Landsat image of the Puerto Breu area.

The objectives of the workshop were to emphasize understanding the basis for Landsat's ability to provide information about vegetated regions and to determine the utility of Landsat information relative to information provided by other remote sensors and traditional ground-based techniques. During the week-long workshop, teams of participants practiced identifying vegetated regions and delineating specific land use and agricultural features on each of the four enlarged Landsat images. Image characteristics observed on the various frames were explained in terms of vegetation and terrain parameters including percent cover, canopy structure and composition, phenology, and elevation, slope, and aspect. Participants used image enhancement techniques such as diazo film processing and color additive viewing. Where possible, they compared Landsat interpretations to map, photographic, and radar coverage.

Results of workshop activities and discussions indicated:

- 1) For agriculture confined to coastal river valleys, Landsat data can serve to illustrate total area in cultivation and more importantly, changes in cultivated area that may occur with changing capacities for irrigation. The predominance of small and irregular fields limits the capability of Landsat for precise areal measurements of fields or limited areas. However, such measurements are possible on large to intermediate scale photography collected periodically for each valley by the Oficina General de Catastro Rural. Although such photography is collected at infrequent intervals, changes in field dimensions probably also occur on an infrequent basis. The multitude of crop types coupled with small and irregular field patterns will generally limit the capability of Landsat for specific crop identification. However, in regions where extensive areas are cultivated in a single crop, the use of appropriate seasonal Landsat data should provide such information. For example, extensive areas of a unique yellow color within the Rio

Chancay valley on the Cajamarca frame were identified as recently harvested rice fields by workshop participants familiar with the agriculture of northern Peru. The class discussed how other phenomena such as timing of irrigation, cultivation practices, and even soil type might enable stratification of agriculture within river valleys.

2) For the mountainous regions of Peru, Landsat is especially advantageous for delineating areas of montane agriculture. Such areas are usually not readily accessible by conventional ground survey techniques, yet are considered to be of significant importance to the agricultural production capabilities of the country. Areas of grassland, important for grazing, can also be identified. It is possible that a temporal analysis of Landsat data could monitor the green-up and condition of grasslands for better scheduling of grazing use. To assist reforestation practices, Landsat can enable locating areas of recent forest loss and, with ancillary data, could be used for planning the location of new forest plantings.

3) In the Peruvian Amazon Region, Landsat is capable of mapping Aguaje and other forest associations that are found in particular drainage conditions prevalent in low jungle areas. In higher jungle areas, the great heterogeneity of species and the existence of topographic variations appear to limit the amount of forest type discrimination provided by Landsat. However, comparison of radar images to Landsat for the Puerto Breu high jungle area revealed some different patterns within the forest cover, suggesting a utility for both types of data. An on-going AID-sponsored grant project conducted by ONERN will address this issue further.

2.3.2 SUMMARY OF ACTIVITIES FOR THE HYDROLOGY/OCEANOGRAPHY WORKSHOP (V. Klemas)

Among the twenty-two registered participants for this discipline group, there were seven oceanographers and fisheries specialists; six meteorologists; five geologists/hydrologists; and several geographers,

agronomists and engineers (see Appendix B). In accordance with the differing backgrounds and interests of the participants, three subgroups were formed to work on specific projects as follows:

2.3.2.1 Oceanography and Fisheries Workshop Project

The fishmeal industry constitutes a major economic resource for Peru, yet changing ocean currents constantly endanger the supply of fish, particularly anchovies. The abundance of fish off the coast of Peru depends on the presence of upwelling. Coastal upwelling is a phenomenon by which nutrients from the dark depths are periodically brought up in certain areas to the sunlit surface layers where photosynthesis can take place and where they can become available to microscopic plant life. These one-celled plants, phytoplankton, provide the base of the complex food chain of ocean life. Provided with nutrients and using energy from the Sun for photosynthesis, they multiply into large masses, offering feasting grounds for zooplankton and larger fish and creating the most productive fish-producing regions in the world.

Fishing yields in these upwelling areas and their immediate vicinity are at least a thousand times higher than in other oceanic areas. The coastal upwelling areas, comprising only one-tenth of one percent of the total area of the world's oceans, are estimated to contain more than half of the ocean's fish catch--a total fishery yield of more than 40 million metric tons a year.

Some upwelling systems take place year after year in specific areas. Others may continue for several years without interruption and then fail catastrophically -- such as the failures of upwelling in 1965, 1971, and 1972 off the coast of Peru. In previous years, the Peruvian upwelling (locally referred to as El Nino) has created the world's most productive fishery area. In 1970, 22 percent of the total world fish catch -- mostly anchovies -- was harvested. With the absence of upwelling in 1971-72, the anchovy catch dropped from 12.3 million tons in 1970 to

4.5 million tons in 1972 -- a tragedy for Peru which for decades had depended on the more than ten million tons of anchovy catch, from which nearly 70 percent of the world's fishmeal was produced. Scientists say the fish stocks are slowly recovering with the resumption of upwelling in 1973, but they have not yet multiplied to their former numbers. This disruption is thought to be caused by overfishing and natural changes in current patterns and biological cycles of the fish.

Meteorological and oceanographic satellites such as SMS, NOAA-5, and SEASAT offer thermal and microwave data which is ideal for observing ocean currents and related features. During the workshop we first reviewed all available data on ocean currents and their effect on the upwelling. Two years of satellite-derived maps of sea surface temperature were used to evaluate their oceanographic applications and to study advection in the eastern part of the subtropical gyre of the South Pacific Ocean. The advance and retreat of a tongue of cool water stretching from the coast of Chile to the northwest under the southeast trade winds were analyzed and explained. The time history of the development of this cool tongue was described, and its different behavior during the two years was related to the 1976 El Nino event. During 1976, advection in the subtropical gyre was much weaker than during the year before. It was concluded that NOAA-5 satellite-derived surface temperature maps form an important new tool in the analysis and monitoring of the time changes of large-scale thermal features at the surface of the ocean. Also the capabilities of SEASAT were reviewed and found useful to Peruvian coastal studies, even if radar data is not available. Recent articles and references were provided to the class.

2.3.2.2 Meteorology Workshop Project

The Andes Mountains divide Peru into three distinct zones. To the west is the coastland, mostly arid, extending from 10 to 100 miles inland and 1,400 miles along the Pacific. In the center are mountains with peaks over 20,000 feet high, lofty plateaus and deep valleys. East

of the mountains are heavily forested slopes leading to the Amazonian plains. Climate ranges from tropical in the eastern lowlands, with temperatures from 75° to 95° and rainfall between 75 and 125 inches annually, to arctic among the snow-capped peaks. The coastal area has an average rainfall of less than 2 inches and temperatures ranging between 55° and 98°.

Since the coastland has frequent cloud cover, yet very little rain, one of the primary interests of Peruvian meteorologists is the ability to predict or induce precipitation in different types of clouds. During the workshop the capabilities of various Metsats were reviewed, and Peruvian cloud-cover imagery analyzed; the applicability of Scofield's method for predicting rainfall from thermal and visible satellite imagery was evaluated for the case of Peru. Visits were made to the radio-observatory at Ancon and SENAMHI, the National Meteorological and Hydrological Service. At both locations the participants were involved in detailed demonstrations of techniques and equipment for weather forecasting and precipitation assessment. Digital analysis and enhancement of Metsat data was pursued at Ancon to differentiate different cloud types along the Peruvian coast.

A detailed list of references and a series of recent articles was provided to the class.

2.3.2.3 Geo-hydrology Workshop Project

As mentioned previously, there is too much water run-off on the jungle side of the mountains in Peru, and insufficient precipitation and run-off on the coast side. As a result hydrologists are interested in diverting water from the jungle side to the coast side by means of canals/tunnels and carefully managing this water by means of special dams, reservoirs and irrigation canals.

The irrigation project for the Majes-Siguas River Valley was selected as the workshop project, since it is of utmost importance to

the Peruvian government. Using enlarged Landsat color composite imagery, overlay maps were constructed showing the area of the Majes-Siguas drainage basin; the drainage patterns; river length and sinuosity; land use, vegetation, and other features. Slope data was obtained from topographic maps. The resulting overlay maps will be used in future irrigation system design for this drainage basin.

In particular, the resulting data will be valuable for annual runoff prediction and water management for optimum irrigation of the arid coastal region.

A detailed list of references, a series of recent articles and a review of future satellite capabilities was provided to the participants.

2.3.2.4 General Observations

1. The workshop was well received and proved to be highly successful. Rarely have I seen such an emotional outflow of gratitude as at the end of these workshops.

2. Each participant gave me not only his mailing address but also his specific area of interest. We plan to cooperate on joint programs for many years to come.

3. Each participant received a list of specific references and articles, all up-to-date and carefully selected.

4. Three laboratories were visited in addition to the facilities at ONERN. Participants were actually able to use data analysis and other equipment at the Ancon Observatory and SENAMHI. A visit to the Military Geographic Institute also was most useful.

5. Each subgroup chose a leader who will continue to disseminate information to his group even after the workshop is over.

6. Despite the hard work, tight schedule and surprises when some of the workshop material did not arrive, the workshop was a useful, delightful experience, especially in view of the seriousness and enthusiasm of the participants.

2.3.3 SUMMARY OF ACTIVITIES FOR THE GEOLOGY WORKSHOP (W. Smith)

The Geology Workshop, held at INGEOMIN during the second week of the seminar, was a unique success when judged in comparison to many similar workshops held elsewhere. Much of this success was directly due to the particular zeal of the participants who were diligent in their exercises, contributed valuable information from personal experience, made voluntary informal contributions to the program and who often remained working considerably longer than the scheduled program hours. The presence of both Peruvian agency personnel and attendees from the local Universities was a valuable factor. The Ecuadorian seminar attendee was present at this workshop.

Informal slide presentations included such subjects as spectral band selection, temporal applications, major geological structure, the identification of indicators of mineralization and some examples of developing country investigations. Several items of literature were provided to the participants. Xeroopies of spectral information on specific types of mineralization were provided to interested persons.

The following persons were particularly helpful during the geology workshop:

Dr. Bernard Mabire, Consulting Geologist

Dr. L. Guillermo Morales-S, Universidad Nacional

Ing. Carlos A. Lazares, INGEOMIN

The Landsat data used for analysis were:

Frame 1379-14521, 6 Aug 73, Cajamarca Area

Frame 1641-14314, 30 April 74, Ica/Pisco - sedimentary geology
and sand dunes

Frame 2206-14023, 16 Aug 75, Puno/Lake Titicaca - linear mapping
and correlation with mineralized districts

Frame 2498-14190, 3 June 76, Huancayo - joint analysis of MSS
and SLAR data. Location of areas for uranium exploration.

SLAR data for the analysis of the Huancayo frame were provided for INGEOMIN's set of SLAR coverage of central Peru flown by Aero-Services in 1972.

Hands-on exercises were undertaken on the following:

- 1) The location and registration of Landsat frames on topographic and geologic maps and the identification of structural patterns, physiographic provinces and features of physical geography.
- 2) The correlation of Landsat and radar data and their use in interpreting such geologic phenomena as faults, folds, displacements, lithology and guides to possible mineralization.
- 3) The preparation of overlays on preprocessed color enlargements of the Pisco, Puno and Huancayo area Landsat imagery to identify stream patterns, mountain systems, volcanism, folded structures and linears. The overlays were compared to existing maps and correlations were made with known geological structures to identify missing information or possible new information.
- 4) The linears identified on the Puno overlays were analyzed in detail in terms of structures related to known mineral districts. Two, possibly three, major linears which were not identified on existing structural maps, were found to be coincident with mineral occurrences. (It was planned to investigate these findings in the field. It was also proposed that these findings be published if the previously undetected phenomena prove to have indicated a structural trend significant for exploration planning.)
- 5) Specific linears and patterns found on other Landsat or radar data were compared with known faults, fracture zones, and the general tectonic framework. The relative advantages of using a variety of data were illustrated.
- 6) Methods of identifying and editing incorrect structural mapping were noted and the limitations of drawing conclusions on radar

data alone was considered. Pertinent examples were found on reconnaissance maps.

- 7) The relationship of vegetation changes to lithology, faulting and regional stratigraphy was discussed.

Individual investigators sought assistance in interpretation of the following in regard to their own studies:

- 1) Identification of guides to uranium mineralization
- 2) Selection of scale of imagery for specific investigations
- 3) The proper enhancement methods for specific structural problems
- 4) The possible applications of infrared sensing from aircraft
- 5) The applications of low angle photography
- 6) The identification of gossans and other chemical alteration
- 7) The relationship of various types of drainage patterns to structure or lithology
- 8) Topographic expressions of various lithologies
- 9) Features of unconsolidated deposits as related to geologic processes
- 10) Interpretation of patterns of volcanic features
- 11) Relating local structures to regional tectonics
- 12) The relationship of coastal features to regional tectonics
- 13) The interpretation of different tones and colors on Landsat data products
- 14) How to order Landsat and other data products and how to obtain specific enhancements
- 15) The interpretation of seasonal differences on Landsat imagery
- 16) The identification of indicators of a wide variety of mineralization

APPENDIX A

FIRST WEEK ATTENDEES

LISTA DE PARTICIPANTES

SEMINARIO REGIONAL SOBRE TECNICAS DE PERCEPCION REMOTA

7-18 AGOSTO 1978

COMISION NACIONAL DE INVESTIGACION Y DESARROLLO AEROSPAZIAL (CONIDA)

ACUÑA GUTIERREZ, Pedro Leoncio
BRAVO CABREJOS, Jorge
CALDERON CHAMOCHUMBI, Carlos H. J.
CHIARRELLA CABALLERO, Andrés
WATANABE TOGASHI, Gonzalo
ESQUERRE CASTRO, Zaniel
COLOMA DE LAS CASAS, Jorge Ricardo

COMITE NACIONAL DE DEFENSA CIVIL

ARGUEDAS MADRIZ, Cesar Jorge

CONETEL SOC. CIVIL DE RESP. LTDA.

GONZALES MURRAY, Abraham

EMBAJADA DE LA UNION DE REPUBLICAS SOCIALISTAS SOVIETICAS

MOUKHTASSIPOV, Alexei

INSTITUTO DE GEOLOGIA Y MINERIA (INGEOMIN)

DAVILA BURGA, Jorge
LA TORRE VALDIVIEZO, Oscar
LAU, Maria

MABIRE, Bernard
MONTTOYA RAMIREZ, Manuel A.
NUÑEZ RODRIGUEZ, Jaime
PECHO GUTIERREZ, Victor
VERA LAZO DE LA VEGA, José
ZEGARRA, Jaime
LAZARES FERNANDEZ, Carlos

INSTITUTO DE INVESTIGACIONES ENERGETICAS Y SERVICIOS DE INGENIERIA
ELECTRICA (INIE)

FELIX SALVADOR, Orlando
SUYO RIVERA, Epifanio
VERASTEGUI TOCRE, Darto

INSTITUTO DEL MAR DEL PERU (IMARPE)

CSIRKE, Jorge
MALDONADO DONGO, Juan Manuel
RIVERA TORCUATO, Indalecio
ZUZUNAGA, Jorge
FLORES PALCIARES, Roberto

INSTITUTO GEOFISICO DEL PERU (IGP)

ALEGRIA VERA, Luis
BARREDA, Eduardo
BUSHBY, Alfredo
ESPINOZA, Jorge
GONZALES DE DOMINGUEZ, Vilma
INDACOCHA ALVAREZ, Clara
LAGOS, Pablo
TISNADO, Gilberto
VELASQUEZ, Angel
DOMINGUEZ, Francisco

INSTITUTO GEOGRAFICO MILITAR (IGM)

CORNEJO BOLIVAR, Antonio
FIGUEROA RIOS, José
MILLONES VALDERRAMA, Manuel
ROGGEPO ALEJOS, Victor H.
ROJAS CASTILLO, Alberto
SAMANEZ CASAS, José Luis
SUYO MENDOZA, Mauro
VALDIVIA TALAVERA, Angel
VILLANUEVA CHIRINOS, Luis O.

INSTITUTO PERUANO DE ENERGIA NUCLEAR (IPEN)

BARRANTES, Eugenio Antón
CANEPA PURTZAGA, Luis
RIVAS ROBLES, Carlos
ROSADO LAURA, Francisco Javier

INTERTECT

CUNY, Frederick C.

MANUEL OJEDA REPRESENTACIONES

OJEDA CHAVEZ, Manuel

MINERO PERU

CARO ORELLANA, Edgardo
GARATE LLERENA, Germán R.

GUERRERO MENDEZ, Tomas
VELA EMANUEL, Justo Alberto

MINISTERIO DE AGRICULTURA Y ALIMENTACION

DIRECCION GENERAL DE AGUAS

AVALOS S., Oscar
BERNAL NEYRA, William
SANTOYO TELLO, Julio Raúl

DIRECCION GENERAL DE CATASTRO RURAL

HUERTA MUÑOZ, Edo
MEDINA RAMIREZ, Orlando
PEÑA FERNANDEZ, Juan Bill
RAMIREZ SIME, Guillermo E.
RIERA SOLANO, Carlos
VASQUEZ PINEDO, Wildor

DIRECCION GENERAL DE IRRIGACIONES

GUERRA CASTILLO, Eduardo
JIMENEZ MOSCOSO, Gustavo
BALLARTE ROMERO, Ivo

DIRECCION GENERAL DE FORESTAL Y FAUNA

GUTIERREZ MERINO, Elías
OJEDA OJEDA, Wilfredo
VILLEGAS VILLEGAS, Joel

OFICINA SECTORIAL DE ESTADISTICA

VELAZCO PEREYRA, Lino

PROYECTO ESPECIAL CHIRA-PIURA

VELASQUEZ DIAZ, José
GUERRA CASTILLO, Eduardo

MINISTERIO DE ENERGIA Y MINAS

DIRECCION GENERAL DE ELECTRICIDAD

GONZALES GUILLEN, Manuel A.
GUISSE MAGALLANES, Alejandro
MUÑOZ NAJAR ZUÑIGA, Javier

DIR. GEN. DE HIDROCARBUROS

GUTIERREZ CHAVEZ, Manuel
MUÑOZ, Héctor
DAVILA, Julio

MISION ALEMANA

BELLIDO ROSAS, Juan Edwin

MINISTERIO DE GUERRA

CHAVEZ MIJICHICH, Vicente
TASAICO DEL SOLAR, José

MINISTERIO DE MARINA

DIRECCION DE HIDROGRAFIA Y NAVEGACION

CICALA COLLAZOS, Juan Carlos

MISION ALEMANA

SOARES DE FREITAS, Armando

OFICINA NACIONAL DE EVALUACION DE RECURSOS NATURALES (ONERN)

ALVAREZ TORRES, Juan
ARMAS AUTERO, Edgardo
CALDERON GOMEZ, Miguel Alfredo
CHIRINOS NUÑEZ, Humberto
DANJOY ARIAS, Walter
DIAZ ARTIEDA, Hernan
DUEÑOS PEREZ, Humberto
FARROMEQUE CHUMBEZ, Arturo
GALARRETA DIAZ, Luis
GONZALES VALENZUELA, Jorge
GRANDES ROJAS, Victor
MANRIQUE PERALTA, Juan
RODRIGUEZ SANCHEZ, Zoila Rosalía
VARGAS ESPARZA, Gilmer
ZAMBRANO IBARRA, Ramiro
ZAMORA JIMENEZ, Carlos
MANABE TOMOTA, Carmen

PESCA PERU

GARCIA CERRUTI, Luis
IZAGUIRRE P., Luis Benito
VILLANUEVA FLORES, Rogelio

PETROLEOS DEL PERU (PETRO-PERU)

BELLIDO PEREA, Manuel
CAMPOS SERRA, Carlos Alfonso
CUADRA CANALES, Francisco
GADEA ACOSTA, Teodoro
HUERTA KOHLER, Ito
KUANG SANCHEZ, Juan
RODRIGUEZ GOMEZ, Aldo
VELARDE N., Pedro J.

SERVICIO NACIONAL DE METEOROLOGIA E HIDROLOGIA (SENAMHI)

BUSTIOS DAVILA, Carlos Alberto
CACERES MARISCAL, Raúl
CALDAS ZELAYA, Gildo
CULQUI DIAZ, Elizabeth
GUEVARA CALMET, Oscar
GUILLEN BENDEZU, Luis Enrique
RAMOS ROMERO, Humberto
REYES TAVARA, Ricardo
TRELLES ROSSI, Gustavo
YUI KUAN, Juan

UNIVERSIDAD NACIONAL AGRARIA (UNA)

ALMEYDA MAZIAS, Guillermo
AVALOS SANGUINETTI, Oscar
CASAS UCEDA, Juan
FAUSTINO MANCO, Jorge
GOYTENDIA FARFAN, Alejandro
LLERENA P. L. N. 7, Carlos
ORREGO ALBAÑIZ, Arcadio
SHIRASAKA KANNO, Roberto
ZAVALETA GARCIA, Amaro
RODRIGUEZ FALLA, Erasmo

UNIVERSIDAD NACIONAL DE INGENIERIA (UNI)

AGUILAR RODRIGUEZ, José
MARTINEZ TALLA O, José
MOGOLLON SANDOVAL, Enrique
RODRIGUEZ SANCHEZ, Augusto A.
SANCHEZ TARNAWIECKI, Carlos
VALDEZ ROSAS, Gustavo A.

UNIVERSIDAD NACIONAL FEDERICO VILLAREAL (UNFV)

HUAMANI NEIRA, Domingo Walter
TEVES RIVAS, Néstor Alfonso

UNIVERSIDAD NACIONAL MAYOR DE SAN MARCOS (UNMSM)

HONMA SAITO, Victor
LEON CHINCHA, Pascual
LEON NUÑEZ, Carlos
MORALES SERRANO, Luis Guillermo
SAAVEDRA ALVA, Lutzgardo
TARMEÑO BERNUY, Julio Alberto
VISO TOLEDO, Rolando
NIZAMA ESPINOZA, Víctor Raúl
MEZARINA, Luis Enrique

DE PIINO RENGIFO Adber
TOVAR SERPA, Oscar
ACOSTA NAJARRO, Dwight

UNIVERSIDAD NACIONAL SAN LUIS GONZAGA DE ICA

MAZZOTTI PRETELL, Luis

UNIVERSIDAD NACIONAL DEL CENTRO

ACERO VILLANUEVA, Gabriel

UNIVERSIDAD PARTICULAR RICARDO PALMA

BRAVO CABREJOS, Cesar L.
QUINCHO HUACHO, Alipio

UNIVERSIDAD CATOLICA DEL PERU

GARCIA NUÑEZ, Luz Elena

VECINOS MUNDIALES

RUDELL, Eduardo

OTROS

CUENCA, José Manuel - ECUADOR
OCAMPO, Adolfo

RAIDAN, Gregorio - PARAGUAY

WENSJOE MILLER, Thure Eduardo

DOMINGUEZ LECCA, Wilder

APPENDIX B

SECOND WEEK ATTENDEES

SESION-TALLER DE AGRICULTURA

1. Gabriel Acero Villanueva	UNIVERSIDAD NACIONAL DEL CENTRO
2. Pedro Leoncio Acuña Gutiérrez	CONIDA
3. Carlos Alberto Bustíos Dávila	SENAMHI
4. Juan Casas Uceda	UNA
5. Walter Danjoy Arias	ONERN
6. Hernán Díaz Artieda	ONERN
7. Jorge Faustino Manco	UNA
8. Víctor Grande Rojas	ONERN
9. Eduardo Guerra Castillo	PROYECTO CHIRA-PIURA (MIN.AGRICULTURA)
10. Elías Gutiérrez Merino	DGFF-MIN. AGRICULTURA
11. Carlos Llerena Pinto	UNA
12. Juan G. Manrique Peralta	ONERN
13. Manuel Millones Valderrama	IGM
14. Juan Bill Peña Fernández	OGCR-MIN. AGRICULTURA
15. Gregorio Raidán	PARAGUAY
16. Guillermo E. Ramírez Sime	OGCR-MIN. AGRICULTURA
17. Zoila Rosalía Rodríguez Sánchez	ONERN
18. Julio Raúl Santoyo Tello	DGA-MIN. AGRICULTURA
19. Gilmer Vargas Esparza	ONERN
20. Lino Velazco Pereda	OF. SECT. ESTADISTICA (MIN. AGRICULTURA)
21. Amaro Zavaleta García	UNA
22. Joel Villegas Villegas	DGFF-MIN. AGRICULTURA

SESION-TALLER DE OCEANOGRAFIA E HIDROMETEOROLOGIA

1.	Guillermo F. Almeyda Matías	UNA
2.	Oscar Avalos Sanguinetti	DGA-MIN. AGRICULTURA
3.	Juan Carlos Cicala Collazos	DIR. HIDROGRAFIA Y NAVEGACION
4.	Elizabeth Culqui Díaz	SENAMHI
5.	Humberto Chirinos Núñez	ONERN
6.	Arturo Farromeque Chumbez	ONERN
7.	Luis Galarreta Díaz	ONERN
8.	Wilma Gonzáles Campos	IGP
9.	Gustavo Jiménez Moscoso	DGI-MIN. AGRICULTURA
10.	Arcadio Orrego Albañil	UNA
11.	Humberto M. Ramos Romero	SENAMHI
12.	Ricardo Reyes Távara	SENAMHI
13.	Torcuato Rivera	IMARPE
14.	Víctor Roggero Alejos	IGM
15.	Néstor Teves Rivas	U.NAC. F. VILLARREAL
16.	Gilberto Tisnado Manosalva	IGP
17.	Rogelio Villanueva Flores	PESCA PERU
18.	Juan Yui Kuan	SENAMHI
19.	Jorge Zuzunaga Zuzunaga	IMARPE

SESION-TALLER DE GEOLOGIA

1.	Luis Alegría Vera	IGP
2.	Jorge Aurelio Bravo Cabrejos	CONIDA
3.	Luis Cánepa Purizaga	IPEN
4.	Edgardo Caro Orellana	MINERO PERU
5.	José Cuenca Vargas	ECUADOR
6.	Jorge Dávila Burga	INGEOMIN
7.	Orlando Félix Salvador	INIE
8.	Germán Gárate Llerena	MINERO PERU
9.	Manuel Gonzáles Guillén	DGE-MIN. ENERGIA Y MINAS
10.	Alejandro Goytendía Farfán	UNA
11.	Clara Indacochea Alvarez	IGP
12.	Juan Kuang Sánchez	PETRO PERU
13.	Carlos Lazares Fernández	INGEOMIN
14.	Bernard Mabire Bauent	INGEOMIN
15.	Manuel Montoya Ramírez	INGEOMIN
16.	Luis Guillermo Morales Serrano	UNMSM
17.	Víctor Pecho Gutiérrez	INGEOMIN
18.	Aldo Rodríguez Gómez	PETRO PERU
19.	Francisco Rosado Laura	IPEN
20.	Mauro Suyo Mendoza	IGM
21.	Epifanio Suyo Rivera	INIE
22.	José Vera Lazo	INGEOMIN
23.	Darío Verástegui Tocre	INIE
24.	Jaime Zegarra Navarro	INGEOMIN