Landsat Data Users NOTES

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Sioux Falls, S. Dak. 57198

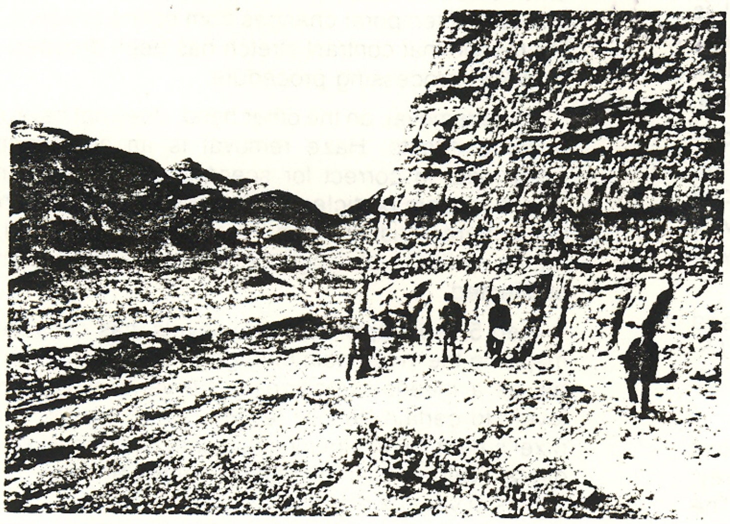
ACTIVITIES WITH THE CHINESE

This summer a team of geologists and remote sensing experts from the U.S. traveled to China to conduct follow-on work initiated last November when a delegation of Chinese scientists visited the U.S. The purpose of the trip was to set the direction of future cooperative work and gain an increased understanding of each country's capabilities and technology. The itinerary included a field trip for the purpose of checking interpretive data obtained from Landsat imagery of China and to gain first-hand knowledge of the geology of the areas being studied.

The U.S. delegation, which included several scientists from the EROS Data Center, was headed by the Chief of the U.S. Geological Survey's Office of Energy Resources. The host organization in China was the Scientific Research Institute for Petroleum Exploration and Development, part of the Ministry of Petroleum.

The trip began with discussions oriented to general topics in geology and overviews of the scientific organizations involved in the work. From there, the team split into two groups which were to take a more detailed interest in remote sensing applications and the geology of China, respectively. The remote sensing group spent additional time with their Chinese counterparts discussing the interpretive work that had been done to date. Analysis results obtained from imagery of the Tsaidam Basin in western China and the Kwangsi-Kwiechow-Yunan Basin in south central China were presented. A field trip was then made to the Tsaidam Basin to check the interpretations.

The Tsaidam Basin proved to be much as expected, geologically, and the interpretative data derived from prior analysis of Landsat imagery checked out quite well. Similar in origin to the Uinta Basin of Wyoming, Tsaidam was a lacustrine setting in an inland basin in ancient times. Many characteristics of the specific geology of Tsaidam had not been seen by Western scientists before this visit.



Some Aspects of China's Geology Had Not Been Studied by Western Scientists Before

After the field trip, the team returned to Peking where they held a workshop for 50 Chinese scientific personnel from all parts of China. The format of the workshop was similar to that used by the EROS Data Center here in the U.S. Principles of remote sensing and an introduction to analysis techniques were supplemented with classroom exercises involving Landsat scenes of China and ground truth data acquired in the field. Topics in computer processing of Landsat data were also covered.

This exchange presented a rare opportunity for U.S. geologists to obtain first-hand knowledge of China's geology, to assess their current progress in related technologies; and it gave the Chinese a chance to learn more about remote sensing and its possible application to the discovery, development, and management of their natural resources.

A Chinese delegation will visit the U.S. this fall for the purpose of selecting and ordering extensive Landsat coverage of their country.

LANDSAT DATA USERS HANDBOOK

Recipients of the *Landsat Data Users Handbook*, now available, will note that two major appendixes to it are not included. These deal with the Landsat computer-compatible tape (CCT) format (Appendix F) and with the various high-density tape (HDT) formats that are currently in use (Appendix H). These subjects are likely to concern only a small and specialized audience; therefore, the appendixes are being made available separately from the EROS Data Center.

Appendix F is also known as the *Manual on Characteristics of Landsat Computer-Compatible Tapes Produced by the EROS Data Center Digital Image Processing System*, a document which has been in circulation since February 1979. The information in it is needed by CCT users. A change to it was recently published consisting of minor corrections to the text and a new explanation of MSS systematic corrections.

Appendix H is still being prepared. It will be a comprehensive format and content specification covering the four types of high-density tapes that are produced for Landsat data: HDT-AM's, HDT-AR's, HDT-PM's, and HDT-PR's. This document will be of value only to those users who plan to process their own HDT's.

Queries about either appendix should be addressed to the User Services Section, EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota 57198, phone: (605)594-6511.

For the *Landsat Data Users Handbook* itself, contact the Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202. The price is $11.00 (25% surcharge for orders outside the U.S., Canada, or Mexico).

EDIPS PROCESSING PROCEDURE CHANGES

A brief note about changes in the standard processing procedure for Landsat data was included in the last issue of the NOTES. Further details now follow.

All Landsat data acquired after February 1, 1979, have been processed according to a fixed digital processing "menu" involving radiometric and geometric corrections at the NASA/Goddard Image Processing Facility and additional standard processing steps by the EROS Digital Image Processing System (EDIPS) at EDC. This fixed menu has included:

1. Radiometric correction of data to adjust for satellite and sensor anomalies.
2. Geometric correction and resampling of data to the Hotine Oblique Mercator map projection.
3. Compensating for atmospheric scatter (haze removal).
4. Stretching of digital brightness values over the dynamic range of film density (contrast stretch.)
5. Mapping of image gray levels to preassigned film density levels through a non-linear lookup table.

Steps 1 and 2 above are done at NASA/Goddard. Steps 3, 4, and 5 have been accomplished at EDC, but recently step 4 was dropped and step 5 was modified.

Contrast stretch provides for magnification of subtle variations in the brightness values contained in the original digital image. A linear stretch over the dynamic range of the brightness levels in the input image is generated by mapping each radiance value encountered (pixel by pixel) in order to separate (or stretch) the pixel radiance levels as much as possible to fill the total image density range. A problem with contrast stretch has been that cloud-free scenes do not result in images with the same brightness values as scenes with clouds. This characteristic can hamper the detection and analysis of temporal changes from scene to scene. It is the reason that contrast stretch has been dropped as a standard processing procedure.

Haze removal, on the other hand, does not have such adverse effects. Haze removal is an adjustment of video data to correct for scene-dependent variances due to random particles in the atmosphere. The brightness characteristics of an image are not changed, but rather shifted, leaving the content of the image unaffected.

Step 5, the mapping of gray levels, has consisted of mapping the video data through a non-linear lookup table as a means of assigning the various digital gray levels to certain density levels in the film. Although a pixel's density on film monotonically increases with the digital value, the differences between the density values of various digital values are not necessarily constant. A modification to the lookup table to make it logarithmic has been implemented to cause the densities on the film to occur in a manner more closely representing the characteristics of the original input data.

The following summarizes the EDIPS standard processing procedure as it currently stands:

1. Radiometric correction
2. Geometric correction
3. Haze removal
4. Gray level to film density transformation via logarithmic lookup

These changes are intended to render a standard Landsat product that will permit easier detection and analysis of scene-to-scene temporal changes and yet provide better image detail than if no enhancements were applied to the video data.

All data processed prior to the time these changes were made will be maintained in the EROS Data Center film archives as they presently exist. If any of these data are re-run through EDIPS for any reason, such as for a special request, they will be processed in accordance with the new procedure.

MSS HIGH GAIN IMAGES

Most of the images acquired by the Landsat satellites to date have been acquired in the low gain (or normal) mode of operation. In addition to this low gain mode, bands 4 and 5 of the MSS can be operated in a high gain mode.

In the low gain mode, the range of brightnesses of objects on the Earth's surface, from absolute black to snow and cloud cover, are spread over the total digital count range of 0 to 127. In the high gain mode, the lower one-third of the total brightness scale is distributed over the 0 to 127 digital range by a 3X amplification, or contrast shift. The processed data from high gain mode therefore yield images with higher brightness and contrast in the low brightness ranges (such as water bodies), but saturates the high brightness areas (such as land).

The high gain mode is especially useful in determining water depth for hydrographic mapping of shallow sea areas. Because of the increased interest in high gain imagery and increased image acquisition in this mode, the EROS Data Center has modified its computerized Main Image File to indicate the high gain images. A new column on the standard inquiry printout indicates the gain mode with an 'H' for high or 'L' for low.

Problems in scheduling special acquisitions of high gain imagery make it difficult to respond to user requests to operate the satellite in this mode. NASA/Goddard tends to discourage such requests from being made.

LANDSAT PRODUCTION PROBLEMS AT NASA/GODDARD

System problems continue to plague the Image Processing Facility at the NASA/Goddard Space Flight Center, which feeds the digital image processing system at the EROS Data Center. The impact on data throughput is significant, as MSS digital data is being processed at a rate of only 60% of that being acquired by the satellite and as RBV digital data processing has not yet started for any Landsat 3 data. Landsat 3 was launched in March of 1978.

RBV TEST TAPE

A computer-compatible tape (CCT) of an RBV subscene produced by the EROS Digital Image Processing System (EDIPS) is available as a test tape to familiarize users with the standard product that will be available when routine digital processing of RBV data begins. An MSS test tape, offered prior to EDIPS operation, is also still available from EDC.

The RBV tape contains a preselected subscene in fully corrected and resampled form. Its characteristics are:

Satellite:	Landsat 3
Sensor:	RBV (subscene A)
Scene ID:	83016618062XA
Path-Row:	047-033 (Oroville, Calif.)
Date of Acquisition:	August 18, 1979
Corrections:	Radiometric Geometric (w/o ground control points) Shading (done on RBV only)
Resampling:	Cubic Convolution
Projection:	Universal Transverse Mercator (UTM)
Density:	800-bpi (two reels) or 1600-bpi (one reel), 9-track
Format:	Subscene Sequential (SSQ)

A 241-mm film transparency will be included with this CCT, along with a computer printout of the histogram and relevant processing data. A document entitled *Manual on Characteristics of Landsat Computer-Compatible Tapes Produced by EROS Data Center Digital Image Processing System* will also be provided to serve as a format specification.

Users may order the RBV test CCT for $50 from the User Services Section, EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota 57198, phone: (605)594-6511, ext. 151. Please indicate the density desired (800 or 1600 bpi).

LANDSAT DATA FLOW

The flow of Landsat data from initial acquisition to final production of master reproducible imagery involves many complex processing steps. The major steps are depicted graphically on this page to show a nominal time line for the total process. The diagram assumes a standard product is being produced -- that is, a fully corrected image with standard processing applied throughout. Since processing of RBV is not yet operational, only MSS is considered.

DAY 1-2

Acquisition begins when the Operations Control Center at NASA/Goddard commands the MSS to acquire data over predetermined areas. If the satellite is within transmitting range of one of the three U.S. reception facilities (in Alaska, California, and Maryland), the data are transmitted immediately. If the satellite is not within range, the data are recorded on onboard tape recorders for transmittal later when the satellite comes into range.

The receiving stations receive the data via tracking antennas and record it on wideband video tape. Each morning, the data received at the Alaskan and Californian stations are transmitted in wideband video form to NASA/Goddard where processing of the data starts. A commercial domestic communications satellite system (Domsat) serves as the link over which these transmissions are made.

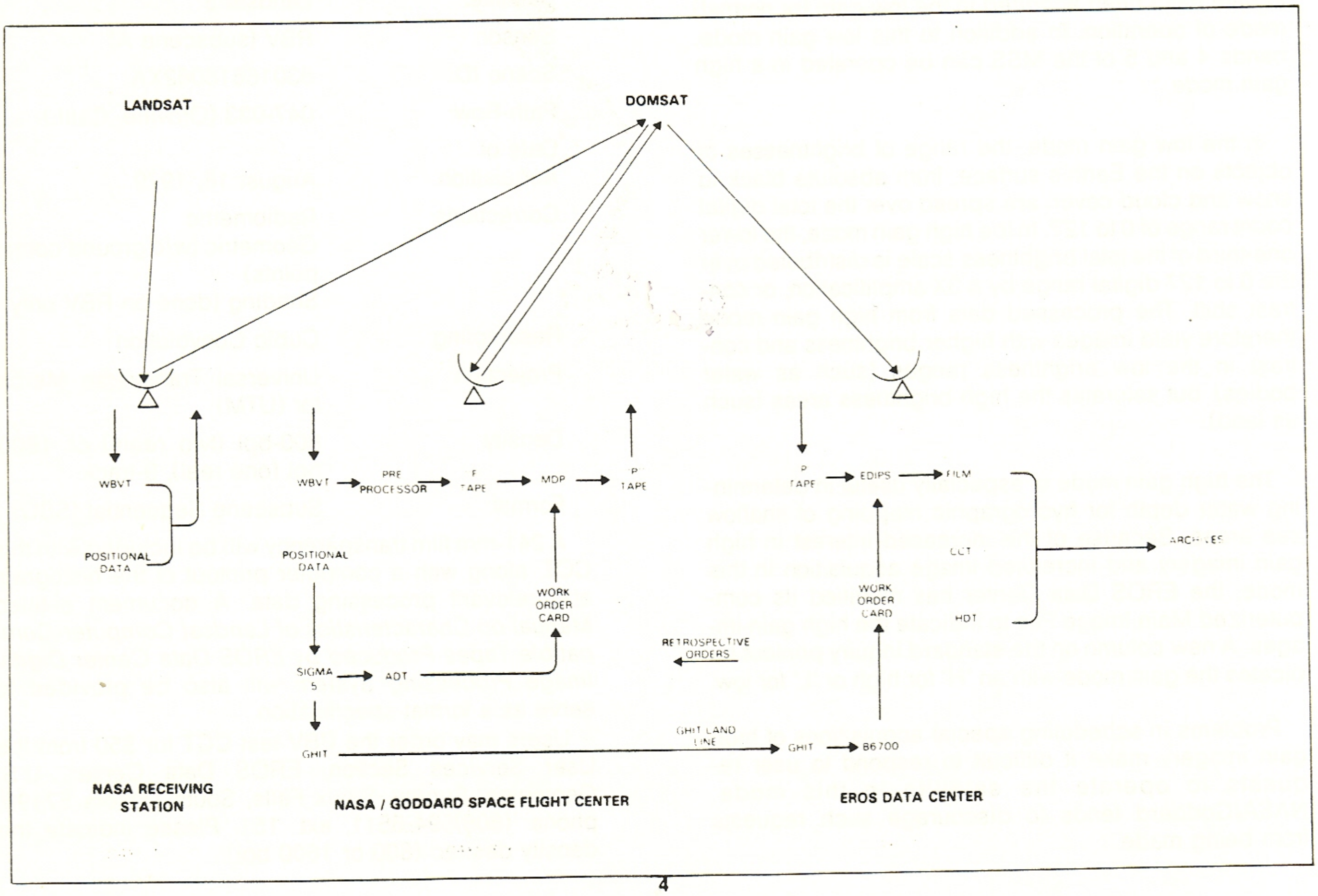
This initial acquisition cycle normally takes approximately 1 to 2 days.

DAY 3-9

At NASA/Goddard, initial processing (pre-processing) consists of converting the wideband video data to digital form. At this time, the data are band interleaved by line. The output is a high-density tape (HDT) known as an "F" tape.

Concurrently, an index tape called the Ancillary Data Tape (ADT) is prepared on the Goddard Sigma 5 computer. The ADT is used to create work order cards which control and schedule the processing of data at Goddard.

The pre-processed digital data are then processed through the Master Data Processor (MDP) which performs both radiometric and geometric corrections. The geometric corrections include corrections for band-to-band offset, line length, Earth rotation, and detector-to-detector sampling delay. In addition, the image data are mapped to the Hotine Oblique Mercator map projection, using a geometric model based on ground control points; or systematic data if ground control points are not available. A cubic convolution resampling technique is utilized in this process. The result is a high-density tape denoted as a "P" tape.



The MDP also creates the annotation data (latitude/longitude tic marks, etc.) which will appear on each image when reproduced. The Sigma 5 computer creates a Goddard HDT Inventory Tape (GHIT) for use later at the EROS Data Center.

This processing by NASA/Goddard currently requires approximately 7 days if no problems are encountered.

DAY 10

When processing at NASA/Goddard is complete, the corrected high-density image tape data are transmitted, using the Domsat communications link, to the EROS Data Center. The digital data microwave transmissions are received by an antenna at EDC and re-recorded on high-density tape. At this point, the data are ready for processing by the EDC Digital Image Processing System (EDIPS).

Concurrently, the Goddard-prepared GHIT is transmitted over a leased-line telecommunications link on the ground. The GHIT is used to prepare EDIPS work order cards for scheduling and control of image data processing at EDC.

DAY 10-12

The high-density image tapes are matched with the corresponding work order cards and both are input to EDIPS. As the tapes are read, a micro-processor generates a histrogram of pixel values, computing the total number of pixels occuring at each of 128 digital levels of intensity. EDIPS then applies a haze removal algorithm and formats the digital data for input to an on-line laser beam recorder. Magnetic tape recorders are also on-line which can accept the formatted data and create computer-compatible tapes (CCT's).

Once exposed, the film is delivered to the EDC Photographic Laboratories. It is developed, inspected, checked for density and scale, and assessed for image quality and cloud cover. After passing quality assurance, it is cut into individual images and archived.

Archival film and the fully processed high-density tapes received from Goddard are maintained at EDC for product generation and dissemination. Computer-compatible tapes are created when needed from the high-density tapes residing in storage.

The processing that takes place at EDC requires approximately 3 days. If no major problems are encountered at any point from original acquisition by NASA to entry into the EDC archives, a total throughput time of 12 days could be expected. Any processing of orders from customers and dissemination of products would follow subsequently.

This nominal time line for throughput of standard products can deviate widely if nonstandard products are involved. These would include products such as corrected data in different map projections or uncorrected data. Such data products must be processed retrospectively through the system and allowances for extra time should be made depending on the particulars of the non-standard product ordered.

THE CORRECTION PROCESS SUMMARIZED

The "corrections" that are routinely applied to Landsat data at NASA/Goddard are necessary because raw image data as received from the satellite contains certain anomalies. These anomalies are introduced during transmission or quantization of brightness levels (radiometric errors), or from variations in the satellite's perspective (geometric errors). Processing of Landsat data on the ground therefore involves two categories of adjustment to compensate for these incongruities.

Radiometric corrections consist of "decompressing" the image data if they have been transmitted in a compressed mode. This is done with a non-linear lookup table, and it brings the range of brightness values up to a range of 0 to 127 from the compressed range of 0 to 63. In addition, gains and offsets are computed and applied to account for differences in individual detectors within a band; this has the effect of producing calibrated brightness values from detector to detector.

The geometric corrections are much more extensive. The raw image data are transformed, based on a correction grid, to a standard map projection: HOM, UTM, or PS. The correction grid is actually two grids, each computed from spacecraft altitude and attitude data to establish an orthagonal "space" of known dimensions. Points in these grids are correlated to pixels in the uncorrected input image, as well as to an intermediary hybrid space, in order to produce an output image with known pixel locations. The analogy of stretching a sheet of rubber over a gridwork of pins describes the result quite well, although the process is entirely mathematical. This transformation provides tie points in the image which can be used to produce an image adjusted for the following spatial distortions:

- Mirror scan non-linearity
- Aspect ratio
- Scan skew (Earth rotation)
- Spacecraft velocity error
- Earth curvature

Additional adjustments for the following along-scan distortions are also made during the image transformation mapping:

- Line length variations
- Fractional band offsets
- Earth rotation (line to line)
- Detector-to-detector sampling delay

The geometric accuracy of the correction grid can be improved if ground control points are used during the computations. With system-level-corrected scenes, the transformation grid is generated based on predictable satellite altitude and attitude characteristics. But with ground control points, these predicted altitude and attitude data can be further refined to correct for non-predictable errors. The attitude model used in the computation of the grid can be adjusted to match the locations of the ground control points. The true geometric accuracy of a corrected scene thus improves in direct proportion to the number of ground control points matched.

Customers ordering digital Landsat data (CCT's or HDT's) can obtain partially processed or fully processed products. The partially processed products contain data to which radiometric corrections have been applied. Correction grid data are provided on the tapes, but have not been applied. Fully processed products have had both radiometric and geometric corrections applied. In the case of both kinds of tapes, an indication of the number of ground points used -- if they are used -- in the derivation of the correction grid is located in byte 232 of the header record for each band.

Film products of Landsat Data may be obtained only as fully processed images. A code appears in the image annotation right after the sun azimuth angle to denote the type of correction data used. This code is an "S" for system-level corrections, and a "G" for ground control point corrections. Film products give no indication of the number of ground control points used.

Additional information on the Landsat data correction processes is available. Appendix F of the *Landsat Data Users Handbook* discusses radiometric corrections, and the decompression tables used, in detail. *EDC Document No. 42* covers the mapping process associated with MSS correction grids. The derivation of the MSS grid and the geometric correction process itself are the subjects of a document currently being prepared at EDC.

EDC TRAINING SCHEDULE

The EROS Data Center's Applications Branch staff will conduct or participate in several training courses and workshops in the coming months.

Oct 1 - Oct 5 *Basic Geology Workshop* (Menlo Park, California). Open to USGS Conservation Division personnel only. Contact: Sharon Enders, USGS Conservation Division, Menlo Park, California.

Oct 9 - Oct 13 *Terrain Analysis: Interpretation of Aerial Photographs and Images* (Sioux Falls, South Dakota). Contact: Lisa Underkoffler, Graduate School of Design, Gund Hall L-37, Harvard University, Cambridge, Massachusetts 02138, phone: (617)495-2578.

Oct 15 - Oct 19 *Remote Sensing for Wetlands Analysis* (NSTL, Bay St. Louis, Mississippi). Open to U.S. Fish and Wildlife Service personnel only. Contact: Dr. Allan Marmelstein, Office of Biological Services, U.S. Fish and Wildlife Service, Washington, D.C.

Oct 15 - Oct 19 *Advanced Geology Workshop* (Sioux Falls, South Dakota). Open enrollment, preference given to U.S. Federal agency personnel. Contact: Branch of Applications, EROS Data Center, Sioux Falls, South Dakota 57198, phone: (605)594-6511, ext. 114.

Oct 22 - Oct 26 *Applications of Geological Remote Sensing to Mineral Exploration* (Rapid City, South Dakota). Contact: Director of Continuing Education, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701, phone: (605)-394-2480.

Oct 23 - Oct 26 *Water Resources Remote Sensing Workshop* (Sioux Falls, South Dakota). Open enrollment, preference given to U.S. Federal agency personnel. Contact: Branch of Applications, EROS Data Center, Sioux Falls, South Dakota 57198, phone: (605)594-6511, ext. 114.

Oct 29 - Oct 30 *Remote Sensing of Agriculture and Rural Land Use* (Mexico City, Mexico). Open enrollment. Sponsored by the Remote Sensing Committee, National Council for Geographic Education. Contact: Dr. Benjamin F. Richardson, Jr., Department of Geography, Carroll College, Waukesha, Wisconsin 53186.

Jan 21 - Jan 25, 1980 *Digital Analysis Workshop* (Sioux Falls, South Dakota). Open to Bureau of Land Management personnel only. Contact: William Bonner, BLM Scientific Systems Development, Denver Service Center, Bldg. 50, Code D-140, Denver, Colorado 80225.

May 5 - May 30, 1980 *International Remote Sensing Workshop* (Sioux Falls, South Dakota). Open to non-U.S. Scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center (917), Reston, Virginia 22092.

Jun 9 - Jun 13, 1980 *Basic Geology Workshop* (Sioux Falls, South Dakota). Open enrollment, preference given to U.S. Federal agency personnel. Contact: Branch of Applications, EROS Data Center, Sioux Falls, South Dakota 57918, phone: (605)594-6511, ext. 114.

Sep 8 - Oct 3, 1980 *International Remote Sensing Workshop* (Sioux Falls, South Dakota). Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center (917), Reston, Virginia 22092.

ADDITIONAL TRAINING IN REMOTE SENSING

Oct 15 - Nov 2 *Introduction to Remote Sensing* (Panama). Also to be held Apr 7-25, 1980, and Sep 8-26, 1980. Instruction in Spanish.

Sponsored by the Defense Mapping Agency, Inter-American Geodetic Survey, and EROS Program. Contact: Chief, DMA-IAGS Cartographic School, APO Miami, Florida 34004.

Oct 22 - Oct 26 *Remote Sensing and Digital Information Extraction* (Washington, D.C.). Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, phone: (202)676-6106.

Oct 24 - Oct 26 *Photo Interpretation Workshop for Environmental Studies* (Orono, Maine). Contact: Conferences and Institutes Division, University of Maine at Orono, 128 College Avenue, Orono, Maine 04473.

Oct 29 - Oct 31 *Mapping From Space, Techniques and Applications* (Washington, D.C.). Also to be held Apr 14-16, 1980. Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, phone: (202)636-6106.

Nov 5 - Nov 9 *Manipulation of Computer-Compatible Tapes* (Panama). Also to be held Apr 28 - May 2, 1980, and Sep 22-26, 1980. Instruction in Spanish. Sponsored by the Defense Mapping Agency, Inter-American Geodetic Survey, and EROS Program. Contact: Chief, DMA-IAGS Cartographic School, APO Miami, Florida 34004.

Nov 5 - Nov 9 *Applied Remote Sensing for Soil Inventory and Assessment* (Pleasant Hill, California). Contact: Sharon Arce, University of California Extension, 2223 Fulton St., Berkeley, California 94720, phone: (415)642-1061.

Nov 12 - Nov 30 *Landsat Mosaic Workshop* (Panama). Also to be held Sep 29 - Oct 17, 1980. Instruction in Spanish. Sponsored by the Defense Mapping Agency, Inter-American Geodetic Survey, and EROS Program. Contact: DMA-IAGS Cartographic School, APO Miami, Florida 34004.

Dec 5 - Dec 7 *Application of Landsat to Earth Resources* (South Australia). Particular emphasis on hydrology, agriculture, and environmental resources. Contact: Keith R. McCoy, South Australian Institute of Technology, P.O. Box 1, Ingle Farm, South Australia 5098.

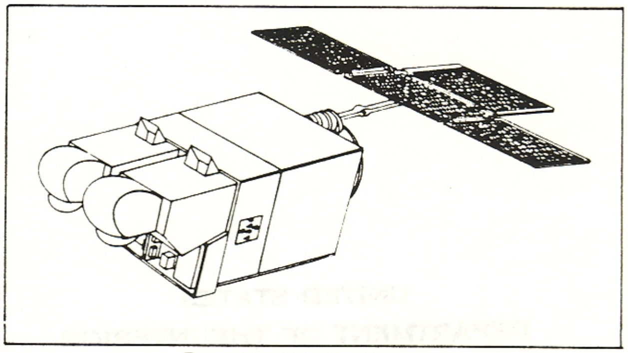
Feb 11 - Mar 7, 1980 *Advanced Training in Digital Image Processing* (Flagstaff, Arizona). Contact: Office of International Geology, U.S. Geological Survey, National Center (917), Reston, Virginia 22092.

Jul 21 - Jul 25, 1980 *International Conference on Soil Conservation* (Bedford, England). Contact: Mrs. P. M. King, National College of Agricultural Engineering, Silsoe, Bedford, England MK 45 4DT.

FRENCH REMOTE SENSING SATELLITE PROGRAM

Le Système Probatoire d'Observation de la Terre (SPOT) is a new remote sensing satellite planned for launch by the French government in 1984. Translated literally, SPOT stands for Earth Observation Test System. Its proposed first mission will be to collect image data for land use investigations: statistical and cartographic surveys, agricultural and forestry resource inventories, environmental studies, and so on.

On its first mission, SPOT will carry two identical, scanning-type, High Resolution Visible (HRV) instruments operating in the visible and near infrared portions of the spectrum. The swath width will be 60 km, and the resolution will be 20 m and 10 m depending on whether the sensors are operating in the multispectral or panchromatic mode respectively. A pointable mirror in each sensor will make it possible to rotate the field of view through an angle of 26°, thus allowing stereoscopic image pairs to be obtained as well as images of areas quite distant from the ground track (up to 400 km away).



The Proposed SPOT Satellite

A low-altitude, circular orbit has been selected which can provide coverage of the entire Earth in a repetitive 26-day cycle if needed. The pointable mirrors could make it possible to image a given area once every 2.5 days. A summary of the SPOT mission characteristics is as follows:

Orbit:	Near-polar, Sun-synchronous 822-km altitude 98.7° inclination Period of 101 minutes 10:30 a.m. descending node (equator)
Coverage cycle:	26 days
Swath width:	60 km
Resolution (IFOV):	10 m (panchromatic mode) 20 m (multispectral mode)
Sensors:	Two High Resolution Visible (HRV) instruments, focal length = 1082 mm, f/3.5

Bandwidths: Panchromatic:
0.5-0.9 micrometers
Multispectral:
0.50-0.59 micrometers
0.61-0.69 micrometers
0.79-0.90 micrometers

Image Products: Landsat-compatible media

The sensors are of the "push-broom" scanning type, requiring no moving mechanical parts such as scanning mirrors, disk choppers, mechanical modulators, etc. Rather, each line of the image is formed by a linear array of detectors located in the instrument focal plane, with the scanning of the line being performed electronically. Successive lines are produced as the satellite moves forward along its orbital track.

The SPOT platform is designed for compatibility with a wide variety of payloads and will probably be used for multiple missions as time goes on.

Planned image products to be made available from the first mission will be supplied on media compatible with those used for Landsat data. HDT's, CCT's, 241-mm film, etc., will be provided in radiometrically and geometrically corrected form. The image annotation data will be similar to that supplied on Landsat images (geographic coordinates, time of acquisition, etc.). Special products currently planned will include orthophotographic scenes which will have been adjusted for terrain relief.

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The Landsat Data Users NOTES is published bi-monthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198, U.S.A., telephone: (605)594-6511.

Comments, corrections, and other inquiries should be directed

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