LATIN AMERICAN CARTOGRAPHIC

EXPERIMENT 496B

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FINAL REPORT

JUNE 1975

Inter American Geodetic Survey
Fort Clayton, Canal Zone

OVERALL EVALUATION OF SKYLAB IMAGERY FOR MAPPING OF LATIN AMERICA

F I N A L R E P O R T

August 1972 - September 1975

EREP Investigation Number 496B

NASA Contract Number T4651B

PRINCIPAL INVESTIGATOR

Jack E. Staples	Defense Mapping Agency Inter American Geodetic Survey

CO-INVESTIGATORS

General de Brigada Jorge José María Roldán	Instituto Geográfico Militar, Argentina
General de Brigada Oscar Wilde Fernández	Instituto Geográfico Militar, Bolivia
Profesor Miguel Alves de Lima	Instituto Brasileiro de Geografía e Estatística
Tte. Cnel. José Mutis Puccio	Instituto Geográfico Militar, Chile
Dr. Alvaro González Fletcher	Instituto Geográfico "Agustín Codazzi", Colombia
Ing. Mario Barrantes Ferrero	Instituto Geográfico Nacional de Costa Rica
Ing. José Joaquín Hungría Morell	Instituto Geográfico Universitario, República Dominicana
Tte. Cnel. Leonardo Endara Romero	Instituto Geográfico Militar, Ecuador
Ing. José Alberto González García	Instituto Geográfico Nacional, El Salvador
Ing. Federico Hernández Cruz	Instituto Geográfico Nacional, Guatemala
Ing. Fernando Lanza Sandoval	Instituto Geográfico Nacional, Honduras
Ing. Humberto Porta Caldera	Instituto Geográfico Nacional, Nicaragua
Ing. Julio Mock C.	Instituto Geográfico Nacional "Tommy Guardia", Panama
General de Brigada Abraham Abed	Instituto Geográfico Militar, Paraguay
Coronel E.P. Guillermo Fernández Dávila Noriega	Instituto Geográfico Militar, Perú
Dr. Adolfo C. Romero	Dirección de Cartografía Nacional, Venezuela

ACKNOWLEDGMENTS

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Grover Compton of the 470th Military Intelligence, for preparing excellent prints of each Skylab map for inclusion in this report.

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FINAL REPORT - Skylab 496-B

Aug 72 - Sep 75

1. BACKGROUND.

a. In April 1971, the request for the Investigation was made by IAGS to NASA to coordinate Skylab experiment in EROS Document 201. On March 16, 1972, a review of the proposed investigation was held by NASA at the Johnson Space Center, Houston, Texas. In August 1972, the experiment proposal was accepted by NASA with contract signatures completed on 9 January 1973. Period of experimentation was until June 1975 and was later extended to September 1975.

b. The investigation involved, in addition to the Inter American Geodetic Survey, seventeen Latin American cartographic agencies as co-investigators. The experiment proposed to accomplish the following objectives:

Determine the utility and economic benefit of Skylab imagery to compile and publish various types and scales of cartographic products (planimetric line maps, photomaps, map revision, thematic and land use maps). Using present cartographic techniques and innovations to be developed, images from the S-190A, S-190B and S-191 sensors will constitute the source material. Available ground control or designated ground control adequate to perform the mapping project will be provided by the IAGS and Latin American participants. Cartographic procedures will be developed for the processing and incorporation of Skylab imagery in the Latin American cartographic community. Each participant will construct various types of maps and provide a detailed evaluation of the results.

2. EREP Technical Investigations:

a. Compile 1:100,000 and 1:250,000 scale controlled photomaps from S190A and S190B imagery in the Argentina - Chile, Paraguay and the Amazon Basin/Central Andes sites.

b. Compile from S190A and S190B imagery, data applicable for 1:100,000 and 1:250,000 scale map revision activities and publish new editions of existing topographic and/or planimetric line maps for the following sites: Chile, Colombia, Venezuela, Costa Rica/ Nicaragua, Guatemala, Jamaica, and Haiti/Dominican Republic.

c. Prepare land use and/or thematic maps for the Paraguay, Bolivia, Venezuela, Costa Rica, Chile and Colombia sites.

d. Evaluate the information content of Skylab data as it pertains to cartography and its application to producing cartographic products within the Latin American cartographic community.

e. The Principal Investigator shall compare the results of Skylab data with ground truth and/or aircraft data over the test sites, evaluating the effectiveness of the developed techniques. These results will be compared with similar results and/or sites obtained from the ERTS application.

f. The Principal Investigator shall determine the adequacy of the EREP sensors for use in various mapping activities of remotely sensed data for earth resources applications and recommend changes for the improvement of future sensors to perform these tasks.

3. Progress of the Work.

a. Imagery Obtained and Distributed (Check Enclosure 1). The initial imagery from S190A (SL2) was received by DMA IAGS in August 1973. A total of 8290 frames of S190A imagery was received during the entire experimentation period, with a total of 14,920 copies (70mm and 9" x 9") of the imagery received and distributed to the co-investigators. The final shipment of the SL4 mission was received in January 1975.

b. The initial shipment of S190B imagery was received by DMA IAGS in September 1973. A total of 1638 scenes of S190B imagery was received during the entire experimentation period, with a total of 3042 copies (both 4.5"x4.5" and 9"x9" enlargements) of the imagery received and distributed to the co-investigators. The final shipment from the SL4 mission was received in January 1975.

c. One scene of S192 imagery (covering Colombia) was received and distributed in October 1974.

4. Operations.

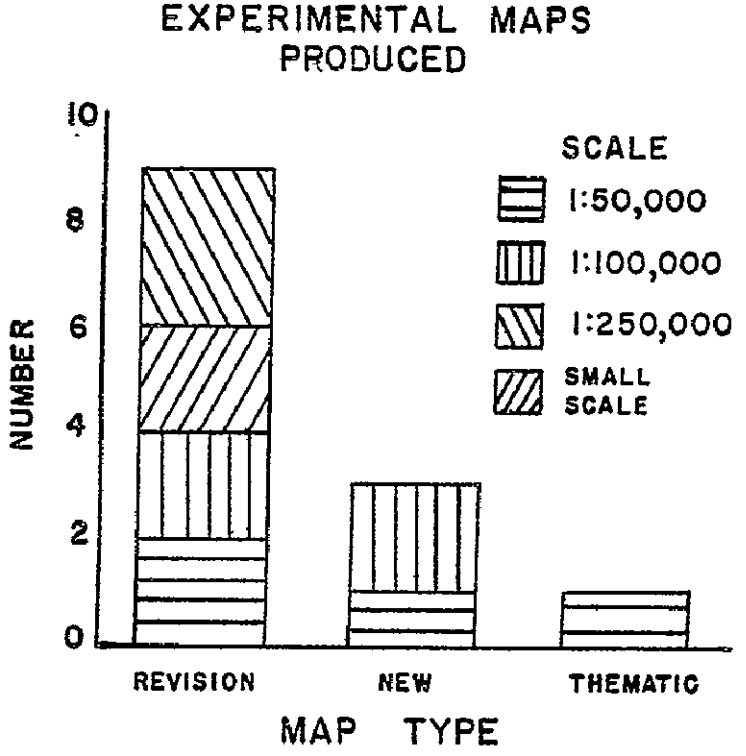
a. In June 1972, DMA IAGS created a satellite imagery cartographic team, consisting of a cartographer and a photographer. As initial S190A imagery was received, the team worked with the national cartographic institutes in Bolivia, Paraguay, and Chile to prepare experimental products utilizing Skylab imagery.

b. As SL3 and SL4 Skylab data became available, scenes were evaluated as to quality and suitability of imagery for providing a cartographic product and recommendations were made to the co-investigators.

c. In June 1975 the principal investigator called a three-day meeting of all co-investigators to present and discuss the various products that had been produced under the experiment and reach conclusions concerning the utility of this data for cartography. The agenda participants and conclusions of this meeting are attached as Enclosure 4.

d. Support was given to the JCS/IAGS/IGM Paraguay Solar Inertial Topographic Mapping Experiment by providing DOPPLER point positions for ground control stations within the experiment area and providing JCS with the computed and photo identified positions. After JCS completed the analytical aerial triangulation and compilation portion, IGM Paraguay completed the drafting and publication of nine of these experimental sheets at 1:100,000 scale. A resume and explanation of this experiment is attached as Enclosure 3.

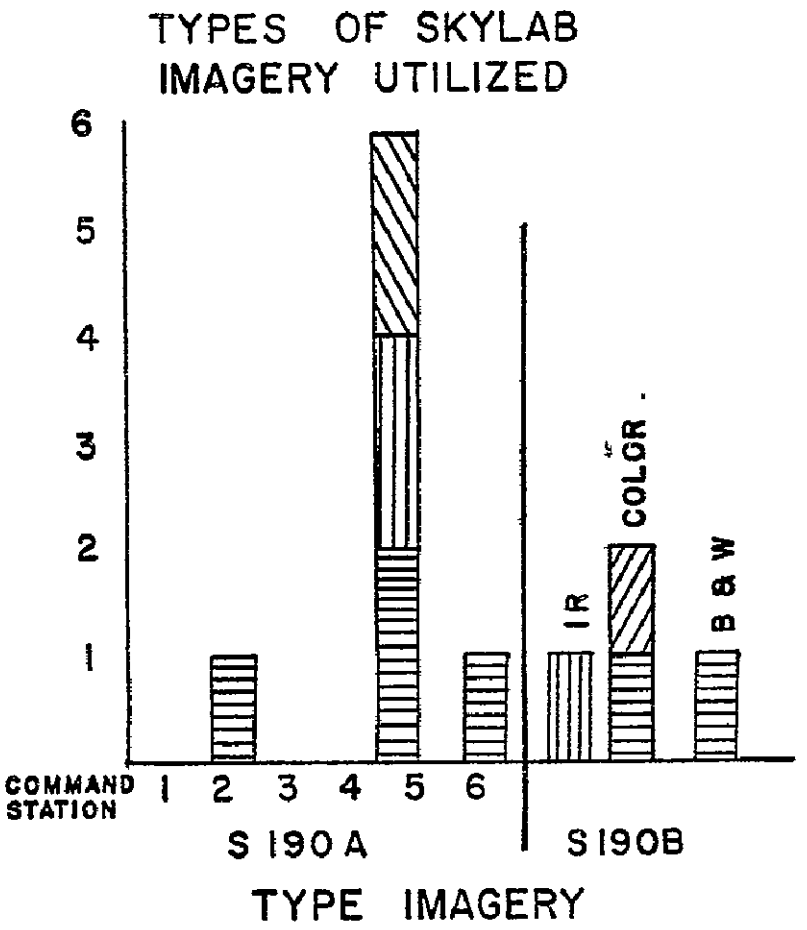
e. A total of fourteen experimental maps were produced by the co-investigators as part of this experiment. These varied from simple revisions of 1:1000,000 to 1:2000,000 national maps to the compilation at 1:50,000 scale of a new map product. The graph below illustrates the type and scale of products produced under this experiment. Detailed explanations and illustrations of the preparation of the majority of these products are attached as Enclosure 2. The initial product, a 1:50,000 scale map revision of Santa Cruz, Bolivia, was produced in March 1974.



5. Procedures Utilized.

a. General. The following procedures are a summary of the presentations and conversations held at the June 25 to 28 Principal Investigators Conference and of the procedures detailed in the enclosed reports.

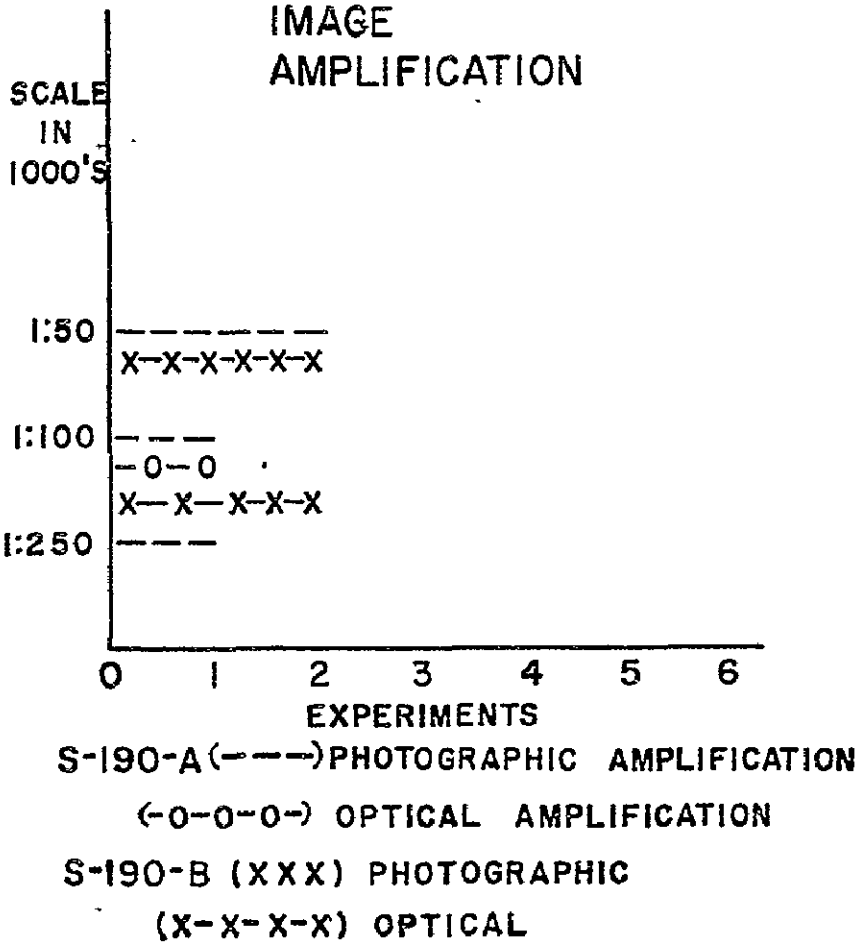
b. Qualitative. Type of Imagery Utilized. The majority of the co-investigators for which S190A imagery was available used Camera Station 5 for the basic imagery in preparing their products In the case of Bolivia, Camera Stations 2, 5 and 6 were utilized to prepare the thematic map. The graph below illustrates the type of imagery used in preparing the experimental products.



c. Image Amplification. Photographic amplification of 70mm or 9" x 9" S190A or 4 1/2" x 4 1/2" S190B was performed using equipment ranging from simple photographic-type enlargers to precision rectifiers. The co-investigators felt that with S190A Camera Station 5 imagery the amplification could be made without graininess appearing up to the 1:250,000 scale. When the 1:100,000 and 1:50,000 scale was achieved, graininess appeared and loss of detail resulted. S190B imagery permitted amplification, normally two-step, to 1:100,000 or 1:50,000 scale without major degradation of the image.

Optical Mechanical Amplifications normally employed 9" x 9" or 4 1/2" x 4 1/2" film positives placed in a first order binocular stereoscopic plotter equipment, equipped with precision pantographs (Wild A-7, A-8, A-9, B-9, Zeiss C-8). 70mm, S190A imagery was normally amplified to 140mm (1:500,000 scale) diapositives, the stereoscopic models placed on the viewing plates. Using a gear ratio of 1:4 or 1:5, scale of 1:100,000 on the plotting table was obtained. In the case of S190B imagery, the 9" x 9" diapositives were used on a Wild A-8 (F120mm - BX 215mm) with a gear ratio of 1:4 permitting planimetric compilation at 1:50,000 scale.

The illustration below indicates the types of amplification methods used by the co-investigators.



d. Ground Control.

(1) Existing Maps.

(a) S190A. Utilizing existing precise topographic maps at scales 1:50,000 to 1:250,000, the co-investigators employed photo rectifiers to enlarge and fit the Skylab 190A imagery to common identifiable points. In one case, the image was enlarged without rectification and the enlarged prints were placed in a Zoom transferscope to fit onto the published map. In all cases, the investigators reported that the images provided a geometric fit within 1:100,000 scale tolerances for positioning the updated information.

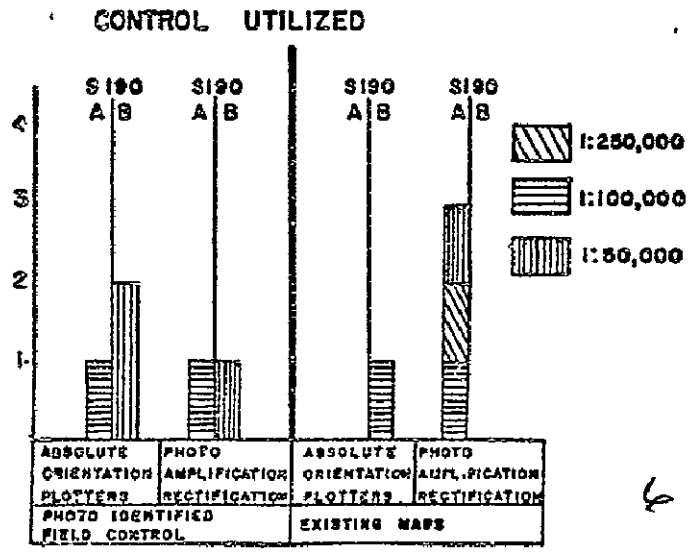
(b) S190B. S190B photography was amplified and rectified to 1:50,000 scale sheet in order to detect cultural change information. The positioning of this enlargement over the existing map registered satisfactorily to permit transfer of the new cultural detail within the 1:50,000 scale map tolerances.

(2) Field Control.

(a) S190A. Utilizing a first order plotting instrument, imagery was satisfactorily given an absolute orientation to three first order traverse and two map controlled points established for 1:50,000 scale mapping. The stereo model was satisfactorily adjusted to the plotting positions within tolerances for 1:100,000 scale mapping.

(b) S190B. Utilizing a first order plotting instrument, the stereo model was satisfactorily adjusted to map control established for 1:50,000 scale mapping. In addition, an attempt was successfully made to provide a horizontal aerial triangulation solution between three adjoining models at the 1:50,000 scale. In a second experiment utilizing black and white pancromatic imagery in a first order plotting instrument, the stereo model was satisfactorily positioned over 8 mapping control points established for 1:50,000 scale mapping. In addition, 11 check points were photo identified to verify that the stereo model could be satisfactorily graphically adjusted to the plotted positions within tolerances for 1:50,000 scale mapping.

The illustration below tabulates the methods of control utilized by the co-investigators in the experiments.



(3) Feature Discrimination. Several methods were utilized in the presentation of the features found on the Skylab imagery onto the appropriate cartographic productions. Some examples of the procedures used are:

(a) Direct Photographic Enlargement, Rectification, and Transfer. This method simply consisted of enlarging the imagery through photographic methods to the appropriate map scale and transferring the images onto the existing map. All co-investigators reported this method satisfactory for updating 1:50,000 through 1:250,000 scale maps where the changed features desired were not detailed. For example, urban build-up and route change, new roads, change of water levels in dams, and change in shore lines were easily discernible utilizing this method. Items requiring high resolution or linear features where image contrast was required were not readily discernible by this method. Only in one case were field parties sent to verify the new information. Most of the co-investigators utilized office interpretation methods.

(b) Optical Amplification, Instrument Rectification and Compilation. This method generally used stereo plotting equipment to amplify the image optically. In one case, a Zeiss Zoom transferscope provided the optical amplification. This method proved superior to that of photographic amplification. When trying to discern specific objects utilizing first order plotting equipment it was possible to discriminate on the S190A imagery features discerned by photographic amplification at 1:100,000 scale plus detect additional features such as individual houses in high contrast area and roads in low contrast areas. The main restriction in precisely locating objects of less than 15 meters resolution was the size of the index dot located in the instrument.

Utilizing S190B black and white photography under the same conditions, resolution was dramatically increased over the entire image area and it was possible to discern fence lines, houses, and small cultural features with a five-to-ten-foot resolution.

6. Significant Results.

a. General. The most significant result of this experiment was making available high resolution space imagery to the Latin American cartographic agencies. This lone fact transcends any specific qualitative or quantitative finding. It has permitted each co-investigator to familiarize his organization with the potentiality and limitations of such imagery and has provided experience in utilizing such imagery for mapping not only non-mapped areas, but for evaluating existing maps and the maintenance.

b. Qualitative.

(1) S190A. The imagery proved that it could be photo amplified to an optimum scale of 1:250,000 and a satisfactory scale of 1:100,000 and still retain the capability to be overlayed on existing precise topographic mapping productions within the tolerances of these products.

(2) For cartographic purposes, Camera Station 5 was found to be the most satisfactory station for cartographic purposes as this station most closely reflected features on topographic maps.

(3) When S190A images were optically enlarged, using a first order photogrammetric plotting instrument, it was possible to satisfactorily adjust the stereo model to plotted field control positions within tolerances for 1:100,000 scale mapping specifications. Optical viewing of this enlarged image was superior in resolution to the photographic enlargements and features of 15 meters' size in high contrast areas could be discerned.

(4) Black and white S190B imagery was found to be superior to all other Skylab products. Utilizing optical amplification in a first order plotter, the stereo model could be satisfactorily adjusted to plotted field control positions for 1:50,000 scale map specifications and features up to 3 meters in high contrast areas could be discerned.

(5) It proved feasible to execute horizontal scaling of three adjoining S190B images in a first order photogrammetric plotter and satisfactorily adjust this triangulation to within tolerances for 1:50,000 scale published map specifications.

c. Direct Benefit.

(1) It was determined that it is feasible to utilize S190A and S190B imagery to update 1:100,000 scale mapping with a major time-saving benefit in the compilation phases. An operator could revise approximately 30 square miles per hour with this imagery as compared to four square miles using the same method with 1:60,000 scale aerial photography. Thus, the time required for this work was one eighth that required using conventional photography.

(2) It was determined that the S190B black and white imagery, because of its resolution, could be utilized to adequately establish horizontal positions and compile cultural features at the 1:50,000 scale within mapping tolerances and without loss of the detailed density required for that scale mapping.

(3) The use of this type of high resolution large coverage imagery to reflect man-made and natural changes was noted dramatically in this experiment. Specifically, recently published maps showed dramatic changes because the original photography used in the compilation predated the map by several years. An entire area showed a major drop in water level of all dams and lakes. The diversion of a river was reflected in the imagery, and the misalignment of a major railroad system was corrected.

7. Practical Applications.

a. Quantitative.

(1) The use of the S190A as data base control photography to control small scale (1:60,000 - 1:100,000) aerial photography to prepare 1:100,000 or 1:250,000 scale mapping.

(2) Utilization of S190B black and white panchromatic imagery as a control data base for medium-scale photography (1:40,000 - 1:60,000) scale photography for preparation of 1:50,000 scale mapping.

b. Qualitative. Use of S190A imagery to maintain currency of planimetric features for precise topographic maps at 1:100,000 - 1:250,000 scale. Use of 190B black and white panchromatic imagery to maintain planimetric information currency for map scale of 1:50,000.

c. Use of S190A and S190B imagery to prepare planimetric maps and photo mosaics of previously unmapped areas at 1:50,000 - 1:250,000 scale.

d. Although only limited imagery is available over Latin America, those countries with sufficient imagery will continue using this imagery. Some examples of practical applications are:

(1) Venezuela plans to continue the exploitation of the available S190A imagery by updating 36 sheets of the 1:100,000 scale national topographic map series.

(2) Costa Rica found that volcanic eruption had diverted the flow of a major river that was going to be used as a prime water source for a hydroelectric project. As a result of this discovery, the pre-feasibility studies on the project were halted.

(3) Guatemala will continue to update their 1:50,000 scale map series utilizing the S190B black and white panchromatic imagery.

(4) Colombia will continue to utilize S190A and S190B imagery to update their 1:100,000 scale national topographic map series.

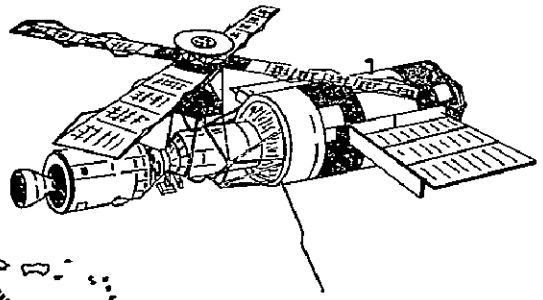
(5) Paraguay. The results of the solar inertial experiment jointly executed by JCS NASA-IAGS-IGM Paraguay will provide further evidence as to the practicability of utilizing this type of satellite imagery to produce precise topographic mapping at the national scales (1:50,000 - 1:250,000) required by the nations for their defense and development.

8. Conclusions. The conclusions stated at the principal investigators final conference will not be repeated in this summary. It is evident from these conclusions that this type of imagery is both desired and needed by the Latin American cartographic agencies, is cost beneficial for the production of new mapping and maintenance of existing maps at national topographic series scales, and could, if available on a near real time routine coverage basis, provide an excellent additional data base to the Latin American cartographic community.

APPENDIX

COVERAGE DIAGRAMS

SKYLAB IMAGES RECEIVED



EROS
EARTH
RESOURCES
OBSERVATION
SYSTEMS PROGRAM

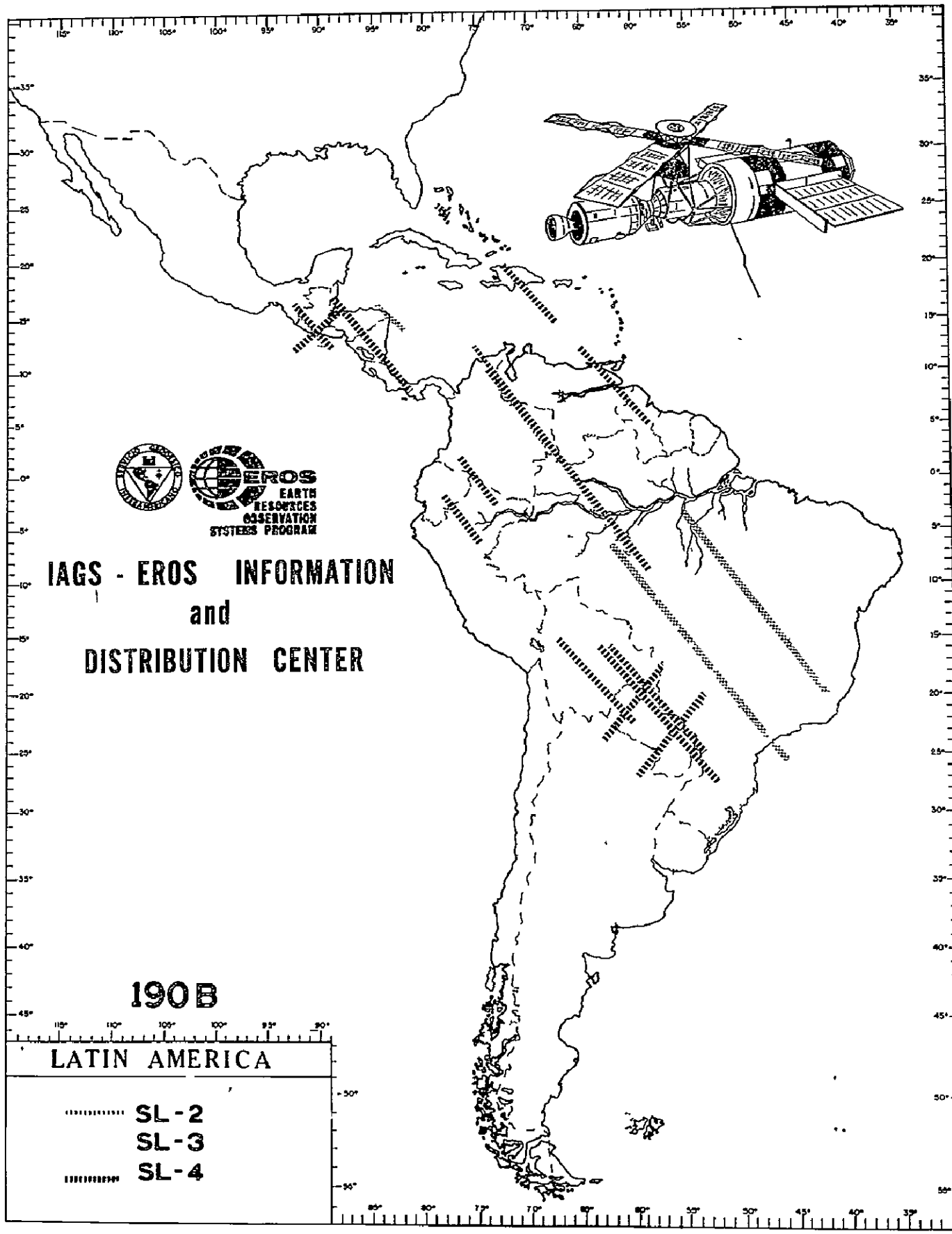
IAGS - EROS INFORMATION and DISTRIBUTION CENTER

190 A

LATIN AMERICA

- SL-2
- SL-3
- SL-4

SKYLAB IMAGES RECEIVED



INDIVIDUAL COUNTRY REPORTS

ARGENTINA

MAPPING IN FLAT AREAS

SCALE OF 1:250,000

ARGENTINA

CO-Investigator: GB Luis Maria Miro

Presented By: ING. ANGEL PEREZ SALA

This experiment was oriented towards the expeditious preparation of a 1:250,000 map for flat areas.

Consequently, and taking into account the SKYLAB III satellite coverage, scenes were selected from frames 200,199,198, and 197, obtained with the S190B camera. This imagery covers a large area of the "Chascomus" sheet (3557-III). The sheet was selected on the basis that it had been printed and compiled by regular mapping techniques at a scale of 1:50,000 and thus served as an excellent experimental tool to planimetric restitution accuracy, as well as photointerpretation quality with small satellite imagery.

PLANIMETRIC RESTITUTION PROCEDURES.

1.1. The principal distance of the S190B imagery projection (of about 460 mm) renders it unfit for analogical reconstruction of each one of the original projected rays with the instrumentation available at the Instituto Geografico Militar. And even assuming it were possible (by proper format and original scale reduction procedures), it would be impossible to obtain a 1:250,000 final product.

1.2. In view of this problem, it was deemed convenient to use a principal distance much shorter than the correct one, considering the flatness of the area to be restituted, and the fact that there was sufficient ground control so as to avoid planimetric error propagation throughout each pair.

1.3. Planimetric restitution was accomplished with a Wild B-9 by adjusting only a few of the 1:50,000 field classification topographic points.

1.4. During the analogic restitution it was determined that despite the "arbitrary" principal distance used (as indicated in 1.2.) relative orientation was possible for each one of the three restituted pairs (with hardly no transversal parallax), undoubtedly due to terrain flatness.
Furthermore, and in support of the procedures followed, it was possible to splice the three consecutive models without any planimetric problem.

1.5. Subsequently, the cartographic product obtained was checked by two different methods as follows:

1.5.1 Using easily identifiable topographic points closely located to restituted features and which "were not used for ground adjustment of each one of the pairs".

1.5.2 By analytical aerial triangulation performed in the AP/C Nistri instrument owned by the Water and Power Department. This instrument permits the "analytical" utilization of correct principal distance, and thus, each one of the image projection rays can be mathematically reconstructed.

CONSIDERATIONS PERTINENT TO CARTOGRAPHIC INTERPRETATION.

With regard to the cartographic interpretation of the restitution performed with the B9 instrument, it is deemed recommendable to mention the following aspects:

2.1. This satellite photography shows greater definition and better possibilities of correct interpretation for roads, rivers, channels, lakes and beaches.

2.2. Railroads are practically non-visible except in the following cases:

2.2.1 Railroads joining adjacent towns and parallel to roadways.

2.2.2 Railroad/roadway crossings.

2.3. Buildings are visible when grouped (e.g. farms), but when isolated they are difficult to identify.

2.4. Land divisions or parceling can be restituted, but markings are difficult to distinguish from fences.

2.5. It should be noted that the color slides received were not used in the planimetric restitution; instead, black and white prints were used and therefore, the full benefits of utilizing color prints were not obtained.

CONCLUSIONS.

This experiment performed by the Instituto Geografico Militar has undoubtedly shown that with proper satellite coverage such as that obtained through the SKYLAB mission, restitution would be possible for extensive unmapped areas of the country, including flat as well as high relief areas, which would result in very significant cartographic products for the country.

On the other hand, final use of satellite imagery in the aerial photogrammetric experiments undertaken by the Instituto Geografico Militar in the province of Cordoba would provide, in the near future, the means to study in greater detail the geometric and photointerpretation aspects of this new technology.

EJÉRCITO ARGENTINO

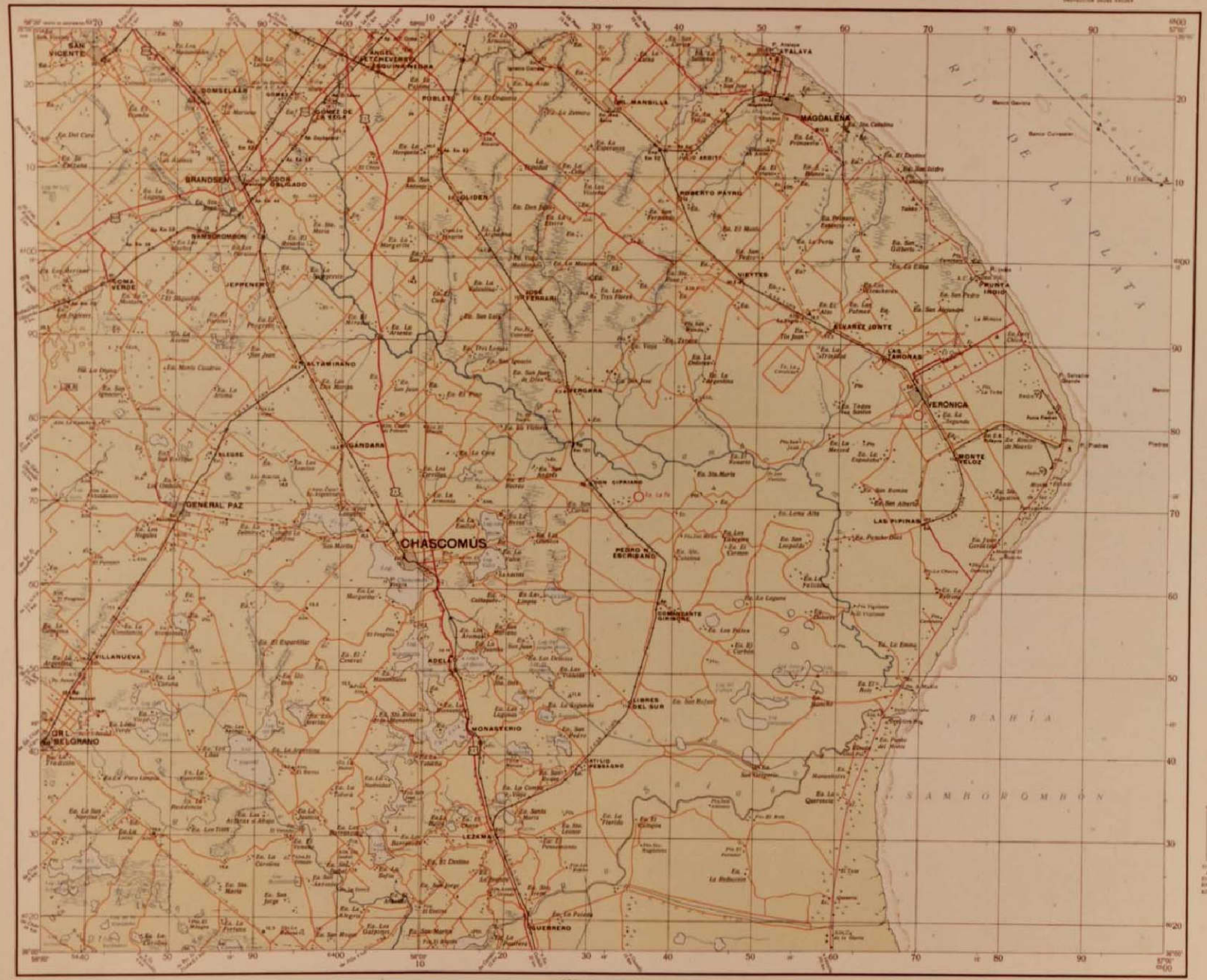
INSTITUTO GEOGRÁFICO MILITAR

CHASCOMÚS

BUENOS AIRES

CARTA DE LA REPUBLICA ARGENTINA

HOJA 3557-III



ESCALA 1: 250 000

REFERENCIAS

CHASCOMÚS

MAGDALENA

LEZAMA

ALEGRE

ABREVIATURAS

CHASCOMÚS

PROVINCIA DE BUENOS AIRES

EJÉRCITO ARGENTINO
INSTITUTO GEOGRÁFICO MILITAR

CARTA DE LA REPÚBLICA ARGENTINA
HOJA 3557-III

ESCALA 1: 250000

MISIÓN SKYLAB SL 3 - 190 R.

ARGENTINA

CARTOGRAFIA EN AREAS PLANAS

ABSTRACTO

Para este experimento, un mapa a escala de 1:250,000, realizado por el Instituto Geográfico de Argentina, se utilizaron cuatro cuadros SL3 S190B cubriendo una parte extensa de la hoja "Cascomus" (3557OIII). Esta hoja había sido impresa y recopilada mediante técnicas cartográficas regulares a una escala de 1:50,000 y por lo tanto sirvió como excelente instrumento experimental para determinar la precisión de la restitución planimétrica. La distancia principal de la proyección del S190B (de aproximadamente 460 mm) la descalificó para reconstrucción analógica de cada uno de los rayos originales proyectados con los instrumentos disponibles en el Instituto. De modo que pudo usarse una distancia principal mucho menor que la correcta por la planicie del área y porque había con suficiente control de campo para evitar error planimétrico. La restitución planimétrica se llevó a cabo con un Wild B-9 ajustando, solo unos cuantos puntos topográficos de clasificación de campo de 1:50,000.

Este experimento demostró que con cubrimiento de satélite tal como el que se obtuvo en la misión SKYLAB, se podrían cartografiar las extensas regiones no cartografiadas en Argentina, incluyendo areas planas y de alto relieve.

* * *

ARGENTINA

MAPPING IN FLAT AREAS

ABSTRACT

This experiment, a 1:250,000 scale map produced by the Instituto Geografico Militar Argentina, used four SL3 S190B frames covering a large area of the "Chascomus" sheet (3557-III) which had been printed and compiled by regular mapping techniques at a scale of 1:50,000 and thus served as an excellent experimental tool to planimetric restitution accuracy. The principal distance of the S190B projection (of about 460 mm) rendered it unfit for analogical reconstruction of each one of the original projected rays with the instrumentation available at the Instituto. Therefore, a principal distance much shorter than the correct one could be used because of the flatness of the area, and because sufficient ground control was available so that planimetric error was avoided. Planimetric restitution was accomplished with a Wild B-9 by adjusting only a few of the 1:50,000 field classification topographic points.

This experiment showed that with satellite coverage such as that obtained through the SKYLAB mission, it would be possible to map the extensive unmapped areas of Argentina, including flat as well as high relief areas.

B O L I V I A

ERTS PROJECT

CO-INVESTIGATOR: BG OSCAR WILDE FERNANDEZ

PRESENTED BY: BG OSCAR WILDE FERNANDEZ

BOLIVIA

1. ERTS PROJECT

The Geological Service of Bolivia (GEOBOL) was designated, by Executive Devree No. 10135, as Principal Investigator for the ERTS-A Bolivia Natural Resources Satellite Program which was designed as a multidisciplinary program including cartography, geology, hydrography and agriculture.

1.1. ORGANIZATION

In order to insure optimum organization of the aforementioned program, the Government of Bolivia appointed the following State agencies for participation:

- Secretaryship for the National Planning Council.
- Ministry of Transportation, Communications and Civil Aeronautics, through the National Meteorological and Hydrological Service.
- Ministry of Agriculture and Cattle Raising, through the Renewable Natural Resources Service.
- Bolivian University of San Andrés, through the Institute of Geosciences.
- Ministry of Defense, through the Military Geographic Institute.
- Ministry of Energy and Hydrocarbon, through the Bolivian Fiscal Oil Deposits -- National Power Department.
- Ministry of Mining and Metallurgy, through the Bolivian Mining Corporation -- Bolivian Geological Service.

1.2. SCOPE

Verification, conexion and complementation between project data and ERTS-1 imagery data for surveying, evaluation and proper utilization of natural resources.

- To establish a national center so as to increase the benefits to be derived from the national use of satellite, aircraft and ground data.

- Participation in ERTS-B, SKYLAB and other programs

with technically trained Project personnel.

- It is considered that the Project will greatly influence the high priority national planning activities.

- Imagery will be used to obtain basic information pertaining to cartography, geology, agriculture and hydrography for future processing and verification.

2. THE MILITARY GEOGRAPHIC INSTITUTE AS CARTOGRAPHIC INVESTIGATOR

The Military Geographic/National Cadaster Institute "General Juan Mariano Mjuía", was founded on 18 September 1936. Later, on 6 May 1948 its mission and assignments were defined, thereby establishing it as the only cartographic technical organization authorized to prepare and publish the Political Map of the Republic and its derivatives at various scales.

2.1. ORGANIZATION

Generally speaking, the organization of the Military Geographic Institute is subject to the Army General Headquarters, with one Command and one Deputy or Technical Command and six Departments: G-1 Personnel, G-2 Public Relations, G-3 Operations (Field and Office), G-4 Management, G-5 Reproduction, and G-6 Geography and Natural Resources.

The latter Department is directly involved with the ERTS Bolivia Program, as principal and sole cartographic investigator with satellite imagery, and is responsible for the following summarized functions:

- To promote, coordinate and divulge the cartographic, geophysic, geographic and related scientific studies which are of interest to the Department.

- To further and perform studies, activities and training in these fields.

- To promote cooperative relations between national and international agencies through the Command of the Military Geographic Institute.

- To divulge the publications of investigations performed in the Department.

- To maintain relations for exchange of information and publications with national and foreign organizations, in order to keep pace with new studies, projects, publications, etc.

3. WORK PERFORMED WITH SATELLITE IMAGERY

In 1973 cartographic investigations were initiated using RBV, Band 1 imagery, which resulted in the publication of the Sucre sheet in the Province of Chuquisaca and which technically contains a series of erros and ommissions that have been accepted in view of the experimental nature of the study. Subsequently, an attempt was made to improve the quality of the sheet by combining the colors and, later, a second printing was made under the same previous conditions.

For the publication of the Map of Bolivia at a scale of 1:1,000,000 (preliminary map) some imagery was used to update hydrographic features because no aerial photography of that area was available.

In February 1974, with the experience acquired through the EROS Program, the Sala de Coipasa map sheet was processed using techniques different from those of the previous sheets, with highly satisfactory results.

Currently we have experimented with the photolysis system known as RANDOM-DOT, which is a satellite imagery contrast control procedure. The test results have been obtained for the following sheet:

- Name of the Sheet: Ciudad de Santa Cruz
- Scale: 1:50,000
- Method: RANDOM-DOT
- Bands: S190A, 5 -6 and 2
- Marginal information and preparation for printing according to current technical manuals.
- Toponymy of the charts published by the Military Geographic Institute at a scale of 1:50,000.

EVALUATION OF THE SANTA CRUZ SHEET

Bands 5, 6 and 2 were used and through a photographic enlargement, definition was possible up to a scale of 1:50,000.

The evaluation performed relates to all linear details such as roads, railroads and beltways, including drainage channels and city block streets which are clearly visible. On the other hand it can be established that hydrographic features such as Rio Piraí, near the city, and the riverheads of several other streams in the area of Espejillos,

are determining in the greater predominance of soil humidity in these areas; this same phenomenom is observed in cultivated areas north of the city.

By comparison with the Linear Chart at the same scale, prepared by the Military Geographic Institute, the following can be established:

> All highways, roads, railroads agree exactly in position.

The plotting of beltways surrounding the city are updated since the SKYLAB data corresponds to 1973 and the Linear Chart to 19__ .

Other observed surface dtails show loss of definition mainly because of the enlargement factor, on account of which enlargements of more than 1:100,000 scale are unadvisable.

CONCLUSIONS

- SKYLAB imagery shows greater definition than ERTS imagery.
- Due to the higher ground resolution, linear features are clearly defined.
- SKYLAB imagery is usefulforupdating linear charts, planimetrically.
- They can be enlarged up to the scale of 1:100,000 with no limitations.
- One of the disadvantages of this system is that it provides very little coverage data in the country, as determined by the attached graphic.

ROUND TABLE DISCUSSION

Usefulness of Satellite Imagery

Up to this date, and based on results obtained from several investigations on satellite imagery, the following can be established:

- Utilization of ERTS 1 or 2 imagery for mapping at scales of 1:250,000 or smaller is justified in areas where no basic cartography is available by traditional methods, as it is of general knowledge that as long as the imagery fails to meet cartographic requirements such as stereoscopic vision, it can only be used for planimetry. These conditions are accepted and can replace

the Charts for the stated reasons -- broad coverage minimum resolution, etc.

- Regarding SKYLAB imagery with an orbital altitude of 534 Km, we are inclined to use the S190B camera system mainly because of the truly remarkable ground resolution: With a focal length of 460 mm, at a scale of 1:946,000, film resolution of 70-60-35 mm corresponds to ground resolution of 14-16-27 meters, according to evaluation performed by Robert B. McEwen.

- Which proves the advantages over ERTS imagery.

- Therefore, we would recommend utilization and corresponding investigation of SKYLAB S190B imagery in the fields of Natural Resources.

- We deem it advisable to request to the corresponding authorities, for the APOLLO/SOYUZ space flights programmed for this year, to complete the ground coverage of South American countries involved in the imagery utilization program.

The ERTS-Bolivia program particularly recommends the completion of the total national territory coverage using SKYLAB S190B or other imagery because it meets more adequately the requirements and provides a more accurate interpretation of the Natural Resources in Bolivia.

BOLIVIA

Mapa Temático - Santa Cruz, Bolivia

Escala de 1:50,000

ABSTRACTO

Este mapa temático fue preparado usando fotografía Skylab 2, S190A, cámaras 2, 5 y 6. Este experimento se hizo con el fin de evaluar todos los detalles lineales claramente visibles tales como caminos, vías férreas, vías de circunvalación, incluyendo canales de drenaje y calles de cuadras urbanas. Comparándose con la Carta Lineal a igual escala se puede establecer que todas las carreteras, caminos y vías férreas concuerdan exactamente en posición. Otros detalles superficiales observados muestran pérdida de definición, principalmente por el factor de ampliación. Por este motivo no se consideran recomendables las ampliaciones a escalas de más de 1:100,000.

* * *

BOLIVIA

Thematic Map - Santa Cruz, Bolivia

1:50,000 Scale

ABSTRACT

This thematic map was prepared using Skylab 2, 190A photography, cameras 2, 5 and 6. The purpose of this experiment was to evaluate all linear details such as roads, railroads and beltways including drainage channels and city block streets which are clearly visible. By comparison with the Linear Chart at the same scale it can be established that all highways, roads and railroads agree exactly in position. Other observed surface details show loss of definition mainly because of the enlargement factor. For this reason enlargements of more than 1:100,000 scale are considered inadvisable.

BOLIVIA

MAP REVISION

SCALE OF 1:50,000

SANTA CRUZ, BOLIVIA

CO-Investigator: BG Oscar Wilde Fernandez

Presented by: BG Oscar Wilde Fernandez

This experimental map revision overprint of the 1:50,000 scale Santa Cruz sheet was the first to be produced from SKYLAB photography in Latin America. The revision has been prepared as a part of the DMA IAGS-EROS SKYLAB Experiment 496B and illustrates the feasibility and advantages of making rapid map revisions using this photography.

The photography used was SL-2 190-A Roll 05 Frames 339-340, Camera Station 5, design band width .6 to .7, Pan-X aerial black and white, type SO-002 film. Photography from Camera 5 was selected because of the approximation in tonal response to conventional panchromatic aerial photography.

The 70 mm negative received from NASA was enlarged two times to an approximate scale of 1:500,000 and a physical size of 140 mm for use in the Wild A-9. Using a gear ratio of 1:4, scale of 1:100,000 on the plotting table was obtained. With the exception of the large floating mark, the A-9 proved to be an ideal instrument for the experiment.

The stereo pair was oriented in the Wild A-9 and rectified to a 1:100,000 scale film positive reduction of the 1:50,000 scale topographic map. Upon completion of the planimetric revision, the compilation was enlarged to the original map scale (1:50,000) on a rectifier, scribed and then overprinted onto the lithograph as it appears.

All revisions indicated by the purple overprint were extracted entirely from the SKYLAB photos without benefit of ground truth data which undoubtedly would reveal more detail for revision. The resolution of the photography restricts identification to linear features since non-linear features such as buildings are not discernible. A comparison of the overprint with the map features will reveal some major changes caused by nature, such as the river course labeled "Rio Piray" and some man-made features, such as the urbanization growth of the City of Santa Cruz.

CONCLUSION

The most significant result of this experiment is that a planimetric revision of a 10' x 15' map sheet at 1:50,000 scale was accomplished photogrammetrically from one stereo pair of photographs within a 24-man hour period.

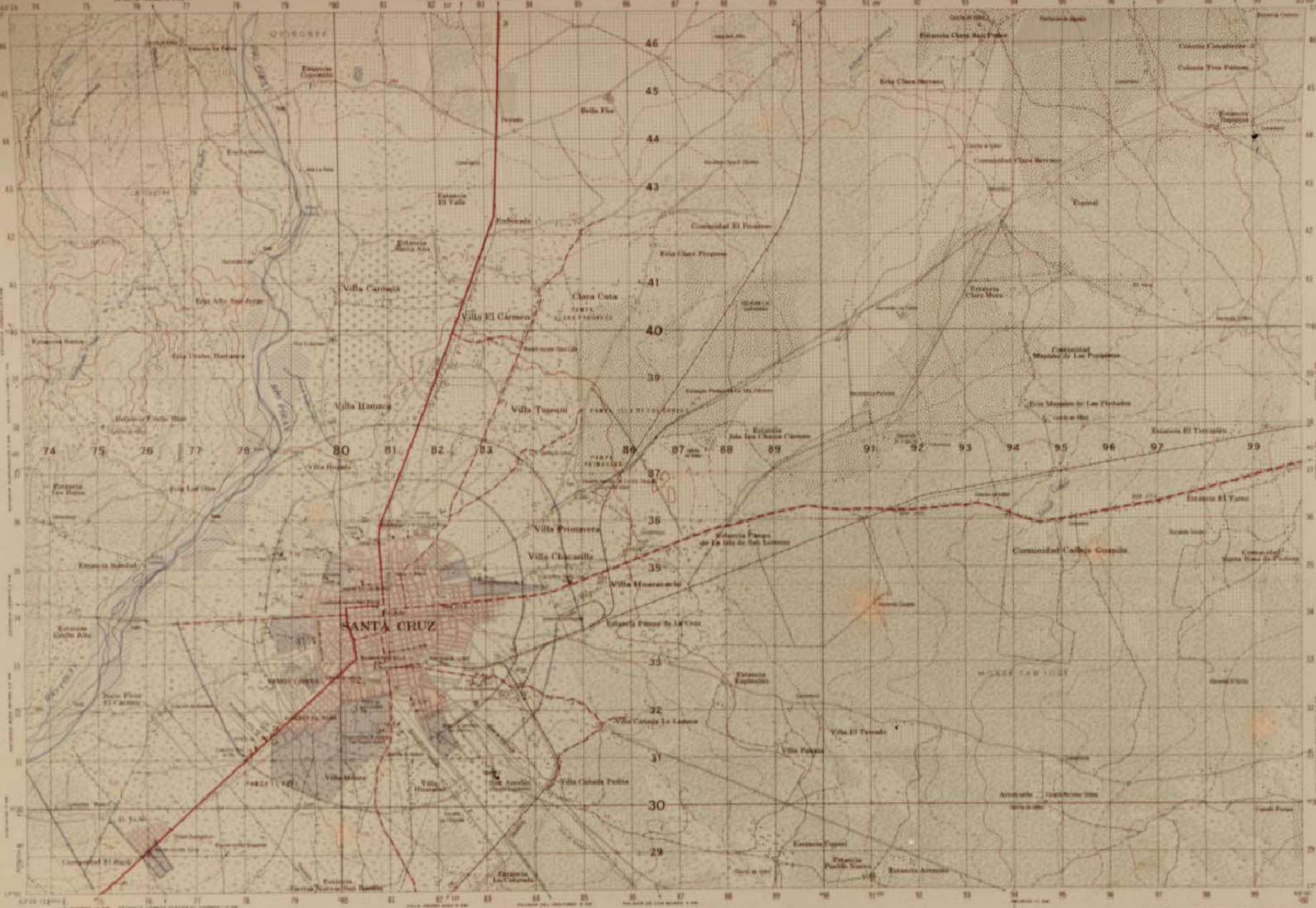
BOLIVIA 1:50,000 DMA-IAGS-EROS SKYLAB EXPERIMENTAL REVISION OVERPRINT

SANTA CRUZ

EDITION 1-TPC

SHEET 6940 I

SERIES H731



Scale 1:50,000

LEGEND

SIGNOS CONVENCIONALES

GLOSSARY

GLOSARIO

The revision overprint in purple was prepared by the IAGS-EROS team in the Canal Zone in the Republic of Panama, February 1974, as an initial photogrammetric experiment with SKYLAB photography (camera S 190A, Station 5) taken June 1973. Revisions were made to planimetric map features by photogrammetric methods (Wild A9). Revisions not field checked or field classified. Authorization for the use and distribution of this map was approved by both the Bolivian and the American (U.S.A.) governments, February 1974.

CONTOUR INTERVAL 20 METERS

WITH SUPPLEMENTARY CONTOURS AT 10 AND 5 METER INTERVALS

CURVAS DE NIVEL CON INTERVALOS DE 20 METROS

SUPLEMENTARIAS A 10 Y 5 METROS

TRANSVERSE MERCATOR PROJECTION

EROS

EARTH RESOURCES OBSERVATION SYSTEMS PROGRAM

SANTA CRUZ, BOLIVIA

STOCK NO. H731X69401***01

BOLIVIA

REVISION CARTOGRAFICA

ABSTRACTO

Esta sobreimpresión de la revisión cartográfica experimental a escala de 1:50,000, demuestra la factibilidad y las ventajas de preparar revisiones cartográficas rápidas usando fotografías SKYLAB. El par estereoscópico de los caudros SL-2, S190A fue orientado en el Wild A-9 y rectificado con respecto al mapa original existente a escala de 1:50,000. La recopilación se sobreimprimió en púrpura, tal como aparece. Esta revisión cartográfica muestra diversos cambios tales como en curso del río y el área urbana de la ciudad de Santa Cruz.

El resultado más significativo de este experimento es que se logró, fotogramétricamente, la revisión planimétrica de una hoja cartográfica de 10 x 15 usando un par estereoscópico de fotografías en un período de 24 horas-hombres.

* * *

BOLIVIA

MAP REVISION

ABSTRACT

This experimental map revision overprint, 1:50,000 scale, illustrates the feasibility and advantages of making rapid map revisions from SKYLAB photography. The stereo pair of SL-2, S190A frames was oriented in the Wild A-9 and rectified to the existing 1:50,000 original map. The compilation was overprinted in purple as it appears. This map revision shows various changes such as the river course and the urbanization of the city of Santa Cruz.

The most significant result of this experiment is that a planimetric revision of a 10 x 15 map sheet was accomplished photogrammetrically from one stereo pair of photographs within a 24 man-hour period.

C H I L E

UPDATING MAPS USING

SKYLAB PHOTOGRAPHY

SCALE 1:50,000

CO-INVESTIGATOR: LTC JOSE MUTIS PUCCIO

PRESENTED BY: LTC JOSE MUTIS PUCCIO
AND
MAJOR VICTOR ODDO

CHILE

UPDATING MAPS USING SKYLAB PHOTOGRAPHY SCALE 1:50,000

1. INTRODUCTION

The study of the earth's crust has for centuries received man's attention as it is the principal source of his subsistance and wealth.

Presently, man threatened by the world-wide population explosion, finds himself confronted with the problem of utilizing his natural resources in the most efficient manner possible. For this reason he is diligently searching for new systems that will permit him to identify and evaluate the earth's resources with speed and accuracy.

With the advent of the space era, new technology is beginning to be utilized with extraordinary efficiency. An example of this technology is "The Study and Evaluation of the Earth's Natural Resources Using Remote Sensing Installed in Satellites and Space Laboratories".

The Earth Resources Observation Systems (EROS) program established by the United States and sponsored by the United States Geological Survey and NASA is designed to develop and integrate the utilization of all earth resources information obtained through satellite, space craft and high altitude airborne remote sensors.

The Earth Resources Technological Satellite (ERTS) and the SKYLAB space laboratory constitute the two basic phases of this program.

2. PROJECT DATA BACKGROUND

At the end of 1972, the Instituto Geografico Militar established an EROS Distribution Center through an agreement with the Defense Mapping Agency, Inter American Geodetic Survey of the United States of America.

A series of SKYLAB photographs of Chilean territory were received in 1973, as part of the overall material received for study. The high resolution of the SKYLAB imagery lends itself to enlargement. Thus, the Cartographic Department of the Instituto was given the job of utilizing this imagery to update 1:50,000 or 1:100,000 scale mapping. In this project only one photograph was

used as stereoscopic models were not available.

The project was accomplished in the following phases:

a) The following prerequisites were applied in selecting the photograph from those available:

- That it correspond to a previously mapped area.

- That it have a minimum of cloud cover.

- That it correspond to a well developed area with many cultural features.

b) The photograph selected is of an area in southern Chile and is identified as follows:

- SL.3, Roll 35, Frame 070, Sep 73. Unfortunately this photograph, one of the best available, has 40% cloud cover.

The photography, at 1:710,000 scale on a 9" x 9" format, was enlarged on a SEG V rectifier and a 1:250,000 scale negative produced. This negative was carefully studied in order to locate an area which met the requirements outlined in a) above, and to meet the size that would fit the rectifier for subsequent enlargement. The selected area of the negative was then cut to size and enlarged to a scale of 1:50,000, rectifying the image and registering it to the corresponding compilation manuscript. Registration was perfect.

By projecting the image onto a sheet of film, a master negative was obtained. Contact positives of the master negative were then produced thus permitting advancement to the next step of the investigation.

c) Following this, work was performed on the topographic map sheet which contained the area corresponding to the enlarged SKYLAB imagery This topographic map, is the 1:50,000 scale Concepcion, Section F, regular series sheet. Aerial photography was obtained in 1954, and field classification accomplished in 1961.

d) A Peel-Coat overlay was registered to the color proof of this map by means of registration buttons, and window cut to expose the work area.

By successively exposing original scribe sheets, a transparent positive containing all the map data was obtained.

From this positive a negative was produced which was used in conjunction with the SKYLAB imagery to produce a scribe sheet in different colors. Based on the SKYLAB imagery which greatly facilitated interpretation, all the new details were scribed on the above sheet.

e) A type overlay was superimposed on the transparent positive of the scribe sheets (d above), thus adding the marginal data to the technical information. Two negatives were then obtained, one in violet and one in black.

f) Work was next done with the scribe sheets and original negatives of the map sheet. Again using the Peel-Coat referenced in paragraph d, a positive of each of the scribe sheets and negatives was obtained.

g) After the above, printing was done in purple to depict the updating.

C O N C L U S I O N

In this investigation only one SKYLAB photograph was used. It is important to point out that the high resolution of this photography is what made this investigation possible.

Even though the details could not be seen stereoscopically nor traced on a compiler, the method used proved acceptable in bringing out the most significant planimetric features.

The system is easily employed and inexpensive. It makes it possible to expeditiously detect changes in urban areas. It is probably not as useful in rural areas except where new roads and other changes in major cultural features are evident.

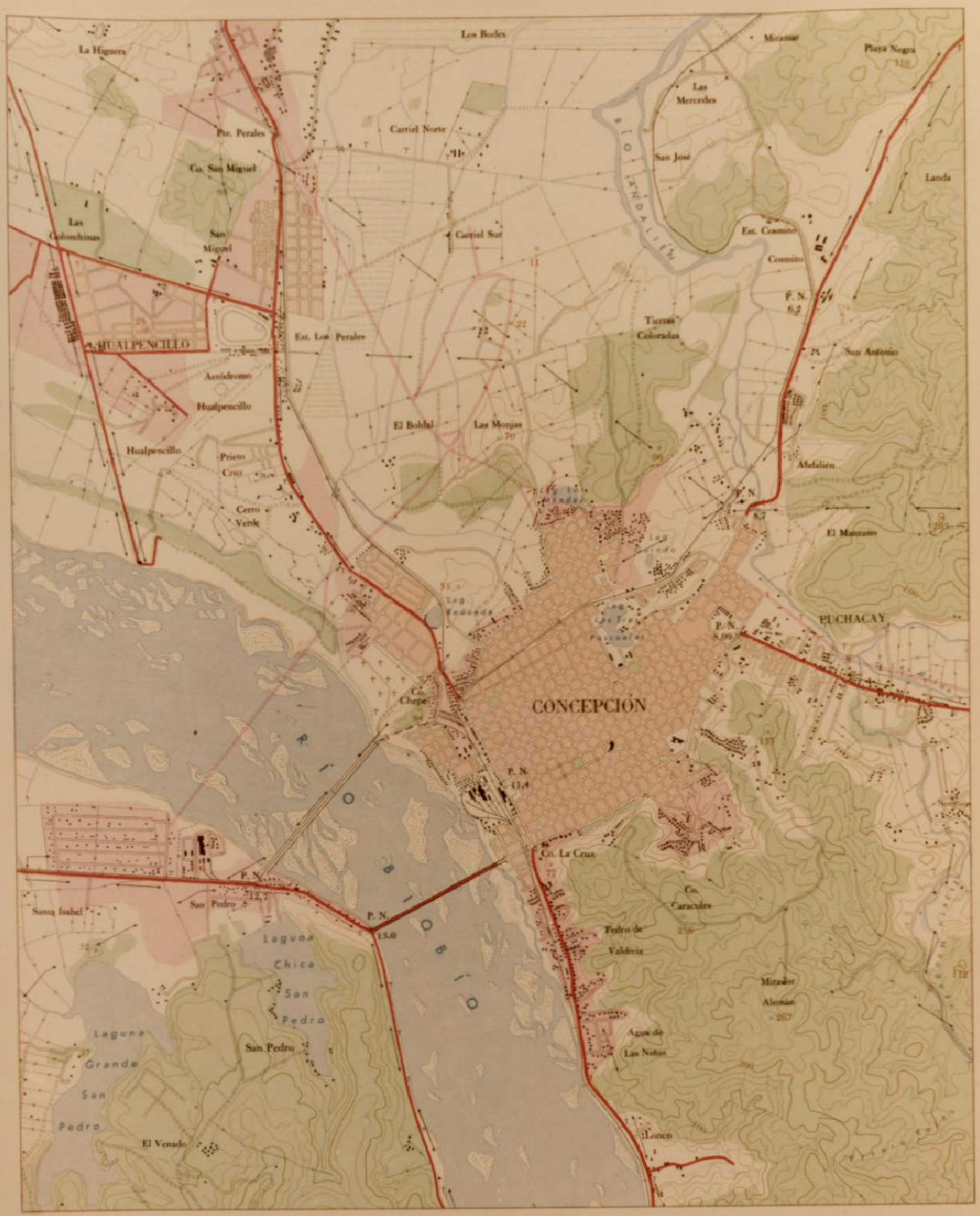
Cloud cover prevented updating the southeastern part of the city of Concepcion. It should be noted that due to the winter season, a field check was not performed which would have allowed to compare the accuracy of the planimetric details in the SKYLAB photography with the accepted tolerances for 1:50,000 scale mapping. At a later date this comparison will be made to complete the investigation.

EXPERIMENTO DE ACTUALIZACIÓN SOBREIMPRESA

CHILE 1:50.000

CONCEPCIÓN

SKYLAB—EXPERIMENTO



Escala 1:50.000

1000 500 0 1000 2000 3000 4000 5000 Metros

1000 500 0 1000 2000 3000 4000 5000 Yardas

Equidistancia curvas de nivel: 25 metros

Información

LEVANTAMIENTO AEROFOTOGRAMÉTRICO
FOTOGRAFÍAS: 1954
CLASIFICACIÓN DE TERRENO: 1961
REACTUALIZACIÓN: 1973

- CARRETERA PANAMERICANA
- CAMINO DE 1ª CLASE PAVIMENTADO CALZADA DE 6 m. O MÁS DE ANCHO
- CAMINO DE 2ª CLASE PAVIMENTADO O RIPIADO CALZADA MENOR DE 6 m. DE ANCHO
- CAMINO DE 3ª CLASE SUELO NATURAL
- HUELLA: SUELO NATURAL SIN MEJORAR
- SENDERO
- VIA FERREA DE TROCHA NORMAL
- PUENTE
- LÍNEA DE ALTA TENSIÓN
- LÍNEA TELEGRÁFICA Y TELEFÓNICA
- ARENAS Y PEDREGALES
- QUEBRADA SECA O INTERMITENTE
- CAÑERÍA DE AGUA POTABLE
- ESCARPAS
- MATORRALES
- VEGA
- ZONA DE BOSQUES

LA ACTUALIZACIÓN SOBREIMPRESA EN COLOR VIOLETA FUÉ PREPARADO POR EL DEPARTAMENTO CARTOGRÁFICO DEL INSTITUTO GEOGRÁFICO MILITAR DE CHILE ; ES UN EXPERIMENTO INICIAL CON FOTOGRAFÍAS DEL SKYLAB (CAMARA S 190, STATION 5) TOMADAS EN JUNIO DE 1973.

LA ACTUALIZACION NO FUE EJECUTADA POR MÉTODOS AEROFOTOGRAMÉTRICOS ESTEREOSCÓPICOS

CONCEPCIÓN, CHILE

CHILE

ACTUALIZACION DE MAPAS A ESCALA DE
1:50,000 CON IMAGENES SKYLAB

ABSTRACTO

Para el experimento SKYLAB en Chile se seleccionó el área de la ciudad de Concepción, al Sur de Chile. La fotografía SKYLAB que se utilizó fue tomada en la misión SKYLAB 3 y es una ampliación de 9" x 9" de la S190A, cámara 5. Esta fotografía fue ampliada en un rectificador SEG V, obteniéndose un negativo a escala de 1:250,000. La parte del negativo correspondiente al área de Concepción se recortó al tamaño requerido y se amplió a una escala de 1:50,000.

Aunque la foto no se pudo observar estereoscópicamente, ni trazar en un estereotrazador, el método demostró ser aceptable para determinar los elementos plaimétricos más significativos, especialmente en las áreas urbanas. La producción del mapa resultó de bajo costo y fácil utilización.

* * *

CHILE

UPDATING 1:50,000 SCALE MAPS
SKYLAB IMAGERY

ABSTRACT

The area selected for the Chile SKYLAB experiment was Concepcion, a city in southern Chile. The SKYLAB photograph was taken on the SKYLAB 3 mission and is a S190A, camera 5, 9" x 9" enlargement. The photograph was enlarged on a SEG V rectifier and a 1:250,000 scale negative was produced. The part of the negative over Concepcion was then cut to size and enlarged to a scale of 1:50,000.

Although the photo could not be seen stereoscopically nor traced on a compiler, this method proved acceptable in bringing out the most significant planimetric features particularly in urban areas. Producing the map was very inexpensive and easily employed.

C O L O M B I A

UPDATING OF MAPS USING SKYLAB IMAGERY

SCALE: 1:100,000

CO-INVESTIGATOR: DR. ALVARO GONZALEZ FLETCHER

PRESENTED BY: DR. RODOLFO LLINAS

COLOMBIA

UPDATING OF MAPS USING SKYLAB IMAGERY
SCALE: 1:100,000

1. INTRODUCTION

Undoubtedly in programs for updating of maps, the scientific advancements in the field of satellite mapping photography offer one of the most effective means for the expeditious accomplishment of work over large areas, with significant savings in cost and manpower.

Using this criteria, the Instituto Geográfico "Agustín Codazzi" included among its work programs for 1974, the updating of sheet No. 25, "FUNCACION", at a scale of 1:100,000 using SKYLAB imagery. This map was published originally in 1959, using aerial photography which had been taken in 1954.

2. AREA LOCATION

The area covered by sheet No. 5 is located between longitudes 74°05' and 74°37' West of Greenwich, and between 10°24' and 10°44' North of the Equator, lying to the Northeast of Colombian territory. It is a flat and lowlying area, near sea-level and 25% of it is covered by swamps and marshland. The largest portion of the area is used for agriculture, mainly banana plantations, including six townsites with an average population of 6,000 and a main center with a population of 20,000. It has an east-to-west unpaved road, and a north-to-south paved road paralleled by a railroad.

3. ELEMENTS USED

3.1 Diapositives

11.5 x 11.5 color diapositives were used, which were furnished directly by the SKYLAB program through the Inter American Geodetic Survey. These frames corresponded to images Nos. 4-91-099 and 4-91-900 and did not cover about 18% of the Northwest corner of the sheet.

3.2 Instrument

An instrument with enough versatility was selected for enlargement from the approximate scale of 1:700,000 (scale of the diapositives) to the scale of 1:100,000 (objective of the work).

From this standpoint, any precision instrument allowing for a 7-times enlargement would be perfectly acceptable,but in our case we preferred to use a universal Zeiss C-8 because of its advantages for any kind of investigation.

3.3 Technical Personnel

The office personnel for this work was selected among the most experienced; however, a photogrammetrist with three years of experience in restitution with precision instruments would be sufficiently qualified for this work.

The field classification personnel included a very experienced engineer and a classifier, this, on account of the experimental nature of the work. But, having established accurate standards, it could be considered as routine field classification.

4. OFFICE WORK

4.1 Orientation of the Stereoscopic Model

The corresponding interior, relative and absolute adjustments were performed with no modifications to the traditional systems, resulting in and ajusted model within the limits specified for the 1:100,000 scale and based on the principle of an acceptable parallax elimination.

4.2 Restitution

In extracting details from photograph to map, several tests were made, and finally, the following elements were selected:

a) Transportation networks such as highways, railroads and roads, as well as other cultural features relative particularly to built-up areas.

b) Hydrographic reatures such as rivers, creeks, lakes and flood areas.

c) Forestry.

d) Altimetry with contours at 100-meter intervals.

All of the above was done for investigation purposes, but the final work centered around the first element, to include hydrographic and altimetric definitions. However, the brief investigation mentioned in points 2, 3, and 4 led to the conclusion that two restituted sheets were necessary; one for culture and one for drainage, with the following recommendations:

a) It is advisable to restitute large rivers, as well as clearly identifiable water areas. Sheet No. 25, which contains various marshland areas, did not show any basic difference regarding the originally restituted sheets, and therefore, this feature remained unchanged.

b) Forest areas cannot be defined without prior field classification.

c) In the altimetry, only a few pass points of the index contours could be checked, and since it was an updating job, it was not deemed necessary to study this in detail, as it was an element of minor variation. However, it could be said that contours can only be drawn in high relief areas with large intervals.

4.3 Time Utilized

The instrument time for restitution of the 2,400 Km2 covered by the sheet totalled 70 hours. This time includes investigations on hydrography, altimetry and some forestry later discarded in the updating. The operator worked with an assistant at the instrument plotting table.

5. FIELD CLASSIFICATION PROCEDURES

5.1 Materials Utilized

In order to perform the field work required for classification updating two restitution sheets were used, along with a photographic enlargement at a scale of 1:100,000 for consultation purposes only.

5.2 Preliminary Office Work

a) Cultural Sheet

By overlaying the new cultural sheet to the old one, it was possible to draft the highway system features not visible to the photogrammetrist; to mark doubtful areas which required special investigation and, later, to indicate those areas which showed noticeable change (constructions, demolitions, buildings, etc.).

b) Drainage Sheet

By overlaying the new drainage sheet over the old one, it was possible to mark changing or doubtful areas in river courses, and to indicate variation in forest areas.

5.3 Field Work

a) All visible roads were classified and all areas marked as doubtful, were investigated.

b) Toponimy was checked, complemented and updated according to scale requirements keeping in mind the development of the area.

c) All important cultural features (schools, churches, etc.) as well as existing changes were updated.

d) All areas marked in the drainage sheet were classified, and hydrography was updated (marshlands, channels, river courses, etc.).

e) Areas showing changes in forest boundaries were investigated and classified.

6. DRAFTING AND PUBLICATION

Drafting and publication were performed by conventional methods.

7. VERIFICATION WITH CONVENTIONAL PHOTOGRAPHY

Using conventional photography at a scale of 1:50,000 taken in 1974, the same area was updated at the identical scale to compare the precision of features restituted with the SKYLAB imagery, and to add data relative to land divisions, hydrography, forests and other planimetric details which had not been previously available. The precision of the map obtained with the SKYLAB imagery was found to be within acceptable limits for the scale of 1:100,000.

The time required for this work was eight times more than that required with the satellite imagery.

8. CONCLUSIONS

The following conclusions only with regard to cultural features can be established.

8.1 Satellite photography, and more precisely, SKYLAB imagery is perfectly useable for the scale of 1:100,000.

8.2 In order to obtain satisfactory accuracy, precision instruments must be used, preferrably a universal instrument.

8.3 The work should be performed by experienced personnel so as to obtain better identification of the features to be updated.

8.4 Field classification should be performed over the restitution originals, separated into drainage and cultural sheets, and air photography should be used only for consultation purposes.

9. RECOMMENDATIONS

9.1 To perform the same type of photogrammetric investigation, but using 24 x 24 cm diapositive enlargements.

9.2 To study a block of several models utilizing lateral and longitudinal aerial photographic coverage to attempt analytic or semi-analytic aerial triangulation adjustment for improvement of the absolute adjustment of the different stereoscopic models.

9.3 The field classification work should assist in establishing and recommending the rivers and creeks that should appear in the updating, especially in areas showing considerable change in river courses (frequent problem in flat and semi-flat areas).

9.4 Undertake an investigation to include the entire forest areas in the updating, as a determining factor which will provide a basis for evaluation of area development or land use variations.

9.5 To undertake the same type of investigations, at a scale of 1:50,000 to add restitution features such as crop divisions, or boundaries which are clearly visible and which could be referred to drainage channels, roads, fences, etc.

REPUBLICA DE COLOMBIA – DPTO. DEL MAGDALENA

FUNDACION

PLANCHA No. 25

COLOMBIA

ACTUALIZACION DE MAPAS A TRAVES DE IMAGENES SKYLAB

ABSTRACTO

El Instituto Geográfico "Agustín Codazzi" actualizó la hoja de mapa número 25, "Fundación" a una escala de 1:100,000 mediante imágenes SKYLAB. Este mapa había sido publicado originalmente en 1959, usando aerofotografías que se habían tomado en 1954. La región que abarca esta hoja es principalmente agricola e incluye un centro principal de población de 20,000 habitantes. Se usaron dos cuadros S190B de la misión SL4 en un instrumento universal Zeiss C-8. Este mapa SKYLAB se comparó con otro mapa de la misma área actualizado mediante fotografía convencional tomada en 1974 y se encontró aceptable dentro de los márgenes permisibles para la escala de 1:100,000. Se comprobó que el uso de fotografía SKYLAB representa un gran ahorro de horas hombres.

* * *

COLOMBIA

UPDATING OF MAPS USING SKYLAB IMAGERY

ABSTRACT

The Instituto Geográfico "Agustín Codazzi", updated map sheet number 25, "FUNDACION", at a scale of 1:100,000 using SKYLAB imagery. This map was originally published in 1958, using aerial photography which had been taken in 1954. The area covered by this sheet is used mainly for agriculture and includes a main population center of 20,000. Two S190B frames from the SL4 mission were used on a universal Zeiss C-8. This SKYLAB map was compared to another updated map of the same area using conventional photography taken in 1974 and was found to be within acceptable limits for the scale 1:100,000. The use of the SKYLAB photography resulted in the saving of many man-hours.

COSTA RICA

EXPERIMENT USING SATELLITE IMAGERY

Co-Investigator: Ing. Mario Barrantes Ferrero

Presented by: Ing. Mario Barrantes Ferrero

COSTA RICA

EXPERIMENT USING SATELLITE IMAGERY

1. It was only possible to obtain a few satellite images of Costa Rica due to the excessive cloud coverage. Thus, a north-Atlantic area of the country was selected for the experiment. This largely forested and slightly developed flat area corresponds to the Rio Sucio sheet.

2. Using photogrammetric restitution based on the original map data at a scale of 1:50,000 and performed with a Wild A-8 Stereoplanigraph, the following natural and cultural features were obtained:

Changes in river courses, channels, railroads and roadways, cultivated and forest areas, airports, etc.

3. The following materials were used:

SKYLAB 4, Roll 52, Frames 356 and 357.

Photography taken in February 1974, at a scale of 1:710,000.

4. The area covered by the experiment is about 500 Km2. The experiment permitted to detect changes in the course of River Chiripo, which had become an affluent of Rio Sucio, after its previous channel had dried up.

In adjusting the 1967 base map to the satellite imagery, a displacement was observed, making it necessary to adjust, by steps, for the photogrammetric restitution of the new natural and cultural features.

It is worthwhile to note that intermediate measures were taken to obtain a scale of 1:50,000.

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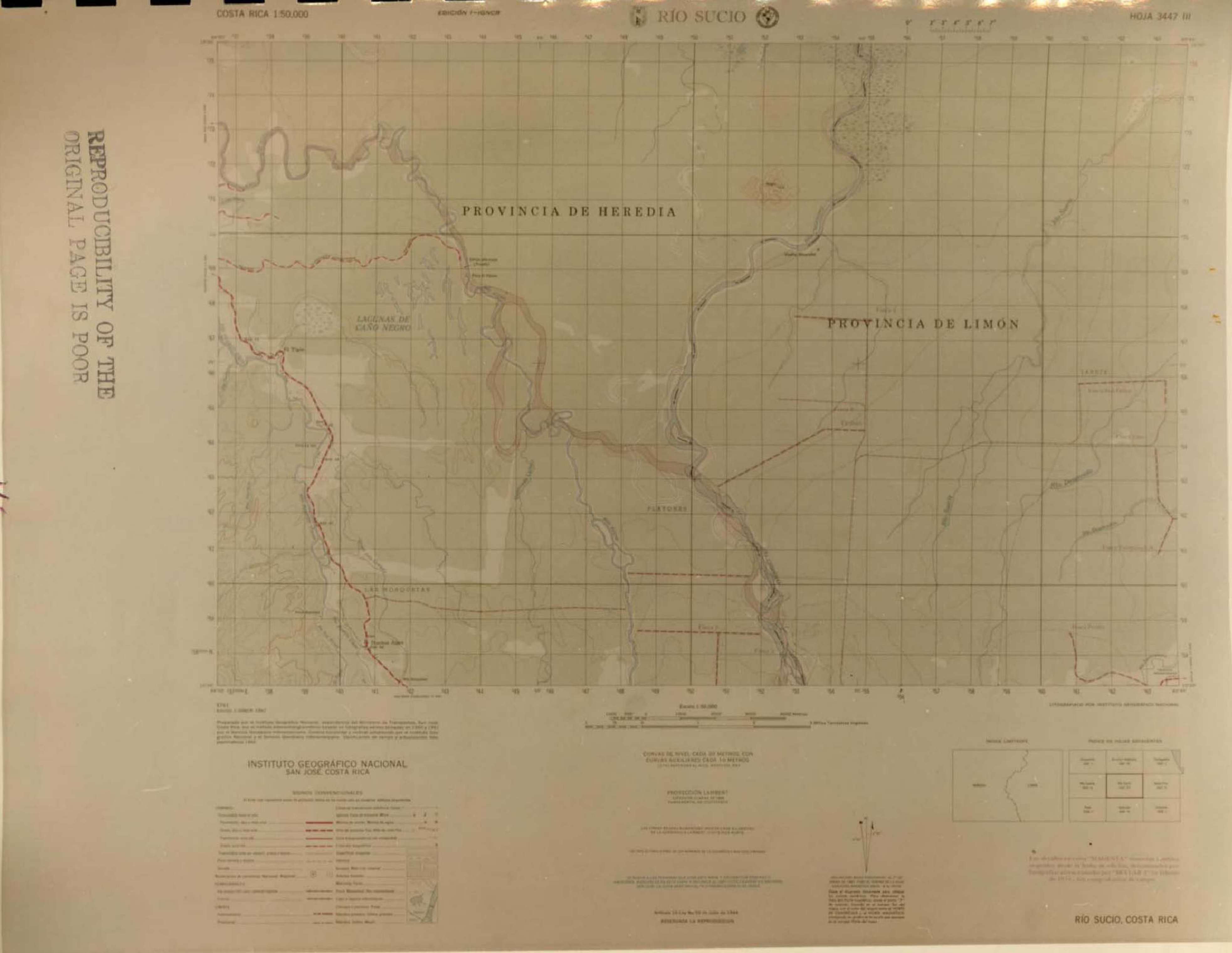


COSTA RICA

EXPERIMENTO USANDO IMAGENES DE SATELITE

ABSTRACTO

Para el experimento SKYLAB se seleccionó una zona en la parte Norte, Atlántico de Costa Rica. Esta es una región plana, muy boscosa y poco desarrollada que corresponde a la Hoja Río Sucio. La restitución fotogramétrica basada en datos del mapa original a escala de 1:50,000 se realizó con un estereoplanígrafo Wild A-8, usando cuadros a colores del S190A, SL4. El experimento permitió al Instituto detectar cambios en el curso del Río Chirripó que se había convertido en afluente del Río Sucio después de haberse secado su antiguo curso. Adjustando el mapa básico de 1967 a las imágenes de satélite se notó un desplazamiento, por lo cual hubo que hacer ajustes, por partes, para la restitución fotogramétrica de las características naturales y artificiales.

* * *

COSTA RICA

EXPERIMENT USING SATELLITE IMAGERY

ABSTRACT

An area in the north Atlantic region of Costa Rica was chosen for SKYLAB experimentation. This is a largely forested and slightly developed flat area that corresponds to the Rio Sucio sheet. The photogrammetric restitution was based on the original map data at a scale of 1:50,000 and performed with a Wild A-8 Stereoplanigraph using SL4, S190A color frames. The experiment permitted the Instituto to detect changes in the course of the River Chiripo, which had become an affluent of Rio Sucio, after the previous channel had dried up. In adjusting the 1967 base map to the satellite imagery, a displacement was observed, making it necessary to adjust by steps the photogrammetric restitution of natural and cultural features.

D O M I N I C A N R E P U B L I C

CARTOGRAPHIC APPLICATIONS USING SKYLAB IMAGERY

CO-INVESTIGATOR
AND
PRESENTED BY: ING. JOSE JOAQUIN HUNGRIA MORELL

GENERAL DIRECTOR
UNIVERSITY GEOGRAPHIC INSTITUTE
UNIVERSITY OF SANTO DOMINGO

DOMINICAN REPUBLIC

CARTOGRAPHIC APPLICATIONS USING SKYLAB IMAGERY

1. INTRODUCTION

1.1. Since the University Geographic Institute expressed its interest in participating with the IAGS in the Latin American SKYLAB Cartographic Experiment (at the 1st Latin American Symposium on Remote Sensing held in Panama in May of 1973), we have been prepared to collaborate in the examination and interpretation of imagery taken from the Space Laboratory, over the Dominican Republic.

1.2. Thus, when we attended the Technical Seminar on ERTS and SKYLAB Photography held at the John F. Kennedy Space Center, during the fall convention of the American Photogrammetry Society, and the American Congress on Surveying and Cartography held in Disneyworld, in October of that same year, and were informed that some SKYLAB imagery of Dominican territory was available, we reiterated our request for copies of said imagery so as to engage in the corresponding investigations.

1.3. However, seemingly the SKYLAB 2 and 3 imagery were hurricane scenes which, because of cloud coverage, obstructed the earth surface visiblity and it was not until a few weeks ago that we received three images covering the southeastern area and a large portion of the northeastern area of Dominican Republic, along the Haiti border.

2. GENERAL TOPOGRAPHIC MAP AT A SCALE OF 1:250,000

2.1. One of the first applications using these images was a map revision and updating experiment of the area of Valle de Neiba contained in the San Juan Sheet NE 19-5 and taken from the General Topographic Map of Dominican Republi at a scale of 1:250,000, compiled in 1970 with data current up to 1968 and published in 1972, as per a cooperative agreement with the United States of America.

2.2. This experiment consisted of a partial interpretation of both enlargements at a scale identical to the map,using SKYLAB scene 296, 70 mm. Rolls No. 67 and 71.

When compared to the map this scene shows a number of recently constructed highways and roads within the area, which is a mainly cultivated sugar cane area located to the northeast of Port Barahona, whose newly built-up surrounding area was also correspondingly outlined.

2.3. Photointerpretation and revision were performed in collaboration with Mr. Duane McDaniel, IAGS Cartographic Representative whose assistance has been very valuable in the preliminary, as well as the preparatory activities for the experiment, and in the planning of future applications and development of relationships with scientists and professionals of other Dominican entities to participate in the various studies projected for the implementation of this imagery in the near future.

2.4. The resulting product of the experiment is presented in an ozalid copy of the aforementioned San Juan sheet, which has been overlayed with plots of the new roads and highways found in the test area, as well as with the contours of the built-up area of Barahona. Also shown are the SKYLAB positive and negative enlargements used in the photointerpretation.

3. BASIC TOPOGRAPHIC MAP AT A SCALE OF 1:50,000

3.1. The other application has been an additional revision and updating of the Barahona sheet 5970, of the basic Topographic Map of Dominican Republic at a scale of 1:50,000, compiled in 1969 with data current up to 1966 and published in 1969, as per the same bilateral cooperative agreement.

3.2. This experiment consisted of the interpretation of an enlargement at a scale identical to the basic map from SKYLAB Frame No. 177, 5 inch film, Roll No. 93. When compared to the map, this frame also showed a number of recently constructed highways and roads within the area covered by the sheet and which also is part of the same cultivated sugar cane area of the first experiment with outlines showing the built-up area of Barahona.

3.3. The resulting product of the experiment is presented in an ozalid copy of a planimetric version of the Barahona Topographic Map sheet which was overlayed with a plot of the new highways and roads found in the test area, as well as with the new outlines for the city of Barahona. Also included is the SKYLAB imagery enlargement used in the photointerpretation.

4. APPLICATIONS IN OTHER STUDIES

4.1. Geology in the Dominican Republic Mountain Range.

4.1.1. A geological study of the Dominican Republic central mountain range was initiated in June of 1975 under the direction of Dr. John F. Lewis of the Department of Geology, George Washington University, and sponsored by the U.S. National Science Foundation, Latin American Cooperative Program in collaboration with Eng. Invan Tavares, Director of the Department of Geology and Mining, the Museum of Natural History of Dominican Republic.

4.1.2. The study plans which also includes the collaboration of the University Geographic Institute, IAGS, the Mining Department and the Technical Department of the Presidency of Dominican Republic pertain to the utilization of ERTS and SKYLAB imagery, as per information covered in a report dated 20 June 1975, prepared by Dr. Lewis, English text of which is submitted with this report.

4.1.3. During the planning of this study, and while attending the International Conference on Cartographic Automation held in Reston, Virginia in December 1974, we informed Dr. Raymond W. Fary, Jr., Remote Sensing Coordinator and other officials of the USGS National Center of the geology project initiated by Dr. Lewis, and requested that they provide him with all possible assistance for acquisition of ERTS and SKYLAB imagery data of Dominican territory.

4.2. Soil Classification and Mapping.

4.2.1. Another important application planned for ERTS and SKYLAB imagery is the program for classification and preparation of semi-detailed maps for agricultural use in Dominican Republic, under the direction of Pieter, L. Arens, who is a scientist of the United Nations Food and Agriculture Organization (UN-FAO), serving the Department of Agriculture.

4.2.2. This program is very important due to soild resources limitations in Dominican Republic because of the high relief in terrain of the majority of its territory, and the resulting natural or man-caused erosion. On account of this and of the high population explosion,

the land must be utilized to the best of its productive capabilities and insured adequate protection against erosion.

4.2.3. Among the characteristics which are visible in the ERTS and SKYLAB imagery to be used as a general basis for the systematic photointerpretation project of agricultural areas, along with semi-detailed and detailed aerial photography, the following are noted: topography and relief, natural drainage, erosion, nature of basic material, vegetation distribution patterns, salinity and other differential features.

4.3. Development of Grasslands and Cattlelands.

4.3.1. Another more recent application for ERTS and SKYLAB imagery concerns a Grassland and Cattleland Development Project undertaken in Dominican Republic by another mission of the United Nations Food and Agriculture Organization, under the Direction of Dr. Ronald A. Peterson, who is the representative for said organization in Dominican Republic.

4.3.2. As part of this project, Dr. Merle Meyer of the Forestry and Remote Sensing Laboratory Department of the University of Minnesota visited the Dominican Republic for 4 weeks and worked closely with the University Geographic Institute and the Inter American Geodetic Survey, while performing detailed photointerpretation of natural pasture lands. He offered the facilities of his University for the preparation of a single mosaic photocomposition of ERTS images to cover the Dominican Republic territory.

4.3.3. Likewise, Dr. Meyer has granted his agreement and support to a project being considered by the Department of Agriculture since the end of 1974, regarding the contracting of vertical aerial photography at a scale of 1:40,000 of all the Dominican territory -- some 48,500 km2 -- in color infrared film for various studies on natural resources, land utilization, urban development, etc., convertible into black and white inter-negatives for cartographic and other purposes.

5. CONCLUSIONS

5.1. The two experiments described in Chapters 2

and 3 indicate that SKYLAB imagery is useful for the revision and updating of topographic maps between the scales of 1:250,000 and 1:50,000 in all those areas, and that it will continue to be useful until such time as semi-detailed or detailed aerial photography of said areas is available to supersede them.

5.2. Based on the sample results of both experiments, a complete revision and updating can be performed of all San Juan sheet at a scale of 1:250,000, as well as of those portions of the Santo Domingo and Santiago sheets partically covered by the three SKYLAB images. This could be supplemented and completed for the five sheets of this general map using ERTS imagery photointerpretation of the entire Dominican territory. Similiarly, the same revsion and updating techniques could be applied to the 123 sheets of the basic topographic map at a scale of 1:50,000.

5.3. Regarding the other applications referred to in Chapter 4, ERTS and SKYLAB imagery is generally useful for the planning and study of various aspects of natural resources, land utilization, environmental problems, urban development, etc. These factors are indicative of the need for, and convenience of reinforcing organizational and human resources for remote sensing in the Dominican Republic, through the establishment and instrumentation of a Remote Sensing Study Center. Said Center would be operated in cooperation with the Unviersity Geographic Institute and the Inter American Geodetic Survey, and would also serve as a laboratory for the scientifica and professional personnel serving other Dominican entities involved in these studies. It could operate jointly and in coordination, as an interdisciplinary technical unit for such purposes.

5.4. The operation of the aforementioned Remote Sensing Study Center would also be greatly enhanced if, for the coming photographic season beginning in December, it were possible to take the projected color infrared aerial photography at a scale of 1:40,000 (which is the intermediate scale between 1:60,000 photography taken from 1958 to 1966, and the 1:20,000 photography taken from 1966 to 1968) of the entire Dominican territory. The excellent resolution would permit comparative studies of variations in land utilization, vegetation patterns, urban development and environmental problems of the last 18 years, during which the population explosion has increased in proportion and impact, thus posing the requirement for adequate and urgent measurers to protect and preserve our natural resources.

MAPA TOPOGRAFICO GENERAL

SCALE 1:250,000
SAN JUAN
DOMINICAN REPUBLIC
REPUBLICA DOMINICANA

ELEVATIONS IN METERS
ELEVACIONES EN METROS
DEPTHS IN FATHOMS
PROFUNDIDAD EN BRAZAS

CONTOUR INTERVAL 100 METERS WITH SUPPLEMENTARY CONTOURS AT 20 METER INTERVALS
INTERVALOS DE CURVAS DE NIVEL 100 METROS CON INTERVALOS DE CURVAS SUPLEMENTARIAS A 20 METROS

00110

REPUBLICA DOMINICANA

APLICACIONES CARTOGRAFICAS USANDO
IMAGENES SKYLAB

ABSTRACTO

El Experimento Cartográfico SKYLAB de la República Deominicana consistió en una revisión cartográfica del área del Valle de Neiba contenida en la Hoja SAN JUAN NE-19. Esta revisión, 1:250,000 fue una de las dos efectuadas por la República Dominicana, consistiendo de la interpretación parcial de dos cuadros S190A, SKYLAB 4, a una escala idéntica de la del mapa. Cuando la revisión se comparó con el original, se pudieron comprobar un número de carreteras y caminos recientemente construidos. Además, se actualizó un mapa topográfico a escala de 1:50,000 usando imágenes SKYLAB.

Los dos experimentos de la República Dominicana han demostrado que las imágenes SKYLAB son utilizables en la revisión y actualización de mapas topográficos entre las escalas de 1:250,000 y 1:50,000. Algunos edificios grandes, carreteras y patrones viales se distinguen con claridad en las imágenes SKYLAB.

* * *

DOMINICAN REPUBLIC

CARTOGRAPHIC APPLICATIONS USING
SKYLAB IMAGERY

ABSTRACT

The SKYLAB Cartographic Experiment of the Dominican Republic was a map revision of the Valle de Neiba Area that was contained in the SAN JUAN Sheet NE-19. This revision, 1:250,000 was one of two done by the Dominican Republic and consisted of partial interpretation of two SKYLAB 4, S190A frames at a scale identical to that of the map. When the revision was compared to the original, the revision showed a number of recently constructed highways and roads. In addition, a topographic map at a scale lf 1:50,000 was updated using SKYLAB imagery.

The two Dominican Republic experiments have proved than SKYLAB imagery is useful for the revision and updating of topographic maps between the scales of 1:250,000 and 1: 250,000 and 1: 50,000. Some large buildings, highways and street patterns are plainly visible on the SKYLAB imagery.

G U A T E M A L A

UTILIZATION OF SKYLAB IMAGERY IN PHOTOGRAMMETRIC RESTITUTION

GUATEMALA

CO-Investigator: Ing. Federico Hernandez Cruz

Presented By: Sergio Antonio Vargas

DESCRIPTION.

a. The stereoscopic pair used was composed of images SL4, 89-290 and SL4, 89-291.

b. 9" x 9" format black and white prints were used.

c. Equipment used was the Wild A-8 Aviograph.

METHOD.

a. Adequate restitution was performed by setting the Aviograph with the values of: f-120 mm and Bx-215 mm.

b. Planimetric restitution scale 1:50,000.

c. Instrument to plotting table enlargement ratio of 1:4.

d. Eight (8) points with horizontal positions (UTM) were used for absolute orientation.

NOTE: These points were assigned a position in order to use them in the cadastral project.

e. Prior to restitution, eleven additional points were identified and positioned, in the office.

RESTITUTION PROCEDURES.

Map Sheet No. 2058 IV (Escuintla) covering 500 square kilometers at a scale of 1:50,000 was used for experimental purposes. (The experiment was limited to planimetry.)

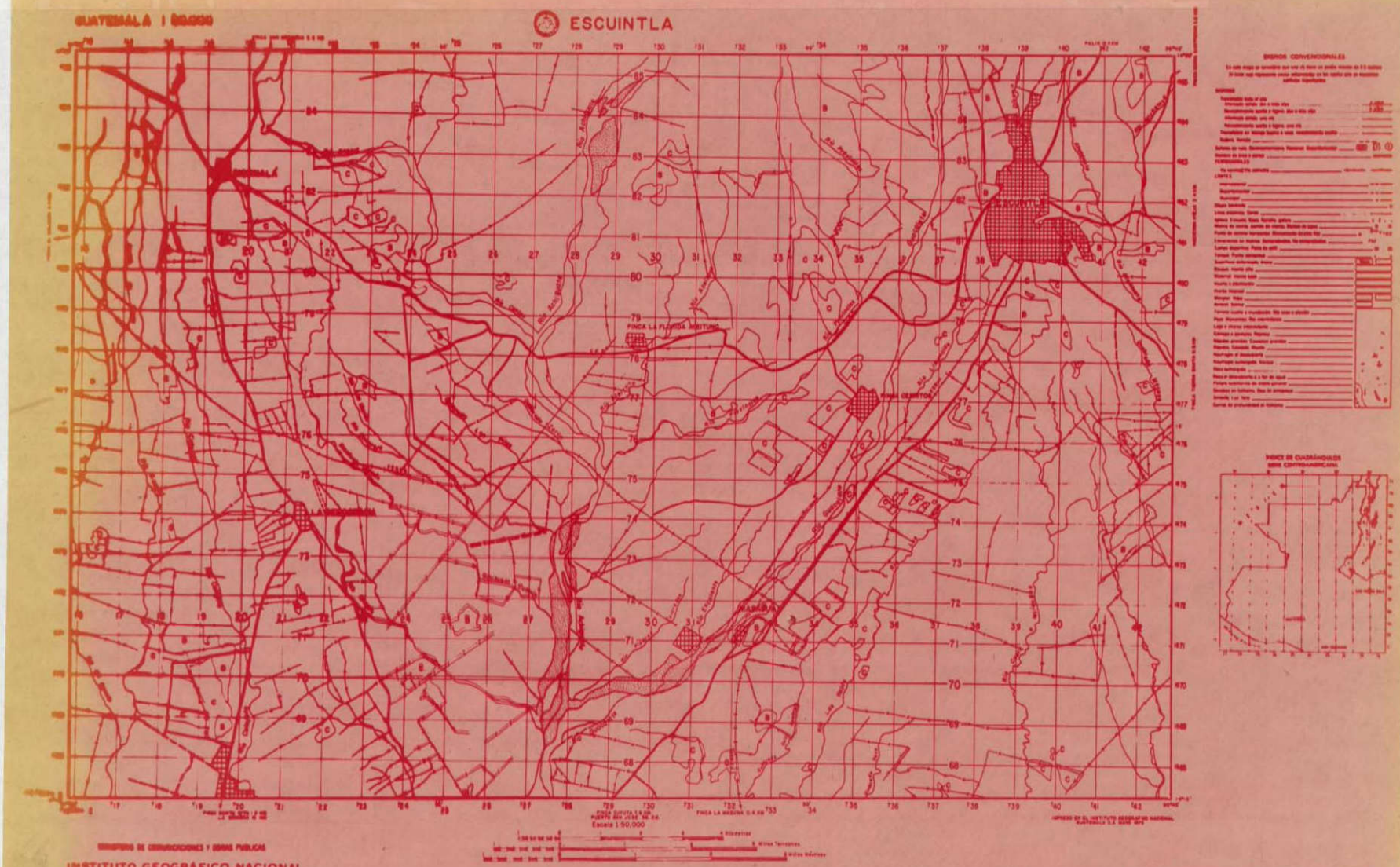
CONCLUSIONS.

a. SKYLAB imagery is perfectly useable for planimetric photogrammetric restitution at medium scales.

b. On account of the detail contained in the imagery, approximations can be used in cadastral studies.

c. Utilization is limited due to lack of resolution in urban areas.

Currently, in Guatemala, an imagery analysis is being performed to determine their utilization in other areas such as Effects of Volcanic Activity, Evaluation of Deforesting processes, Land Utilization, Ownerships, etc.



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GUATEMALA 1:50.000

ESCUINTLA

PRIMERA EDICIÓN - IGN

LA REFERENCIA DE ESTE MAPA ES:
HOJA 2058 IV

MINISTERIO DE COMUNICACIONES Y OBRAS PÚBLICAS

INSTITUTO GEOGRAFICO NACIONAL

GUATEMALA, C.A.

CURVAS DE NIVEL CON INTERVALOS DE 20 METROS

PROYECCIÓN TRANSVERSAL DE MERCATOR

ESCUINTLA, GUATEMALA

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GUATEMALA

APROVECHAMIENTO DE IMAGENES SKYLAB
EN RESTITUCION FOTOGRAMETRICA

ABSTRACTO

En este experimento se utilizó la hoja No. 2058 de Esquintla, a escala de 1:50,000 que cubre 500 kilómetros cuadrados, limitándose dicho experimento a planimetría. En un Aviógrafo Wild A-8 se empleó un par estereoscópico de 9" x 9" blanco y negro de imagenes SL4, S190B, obteniéndose restitución adecuada ajustando el aviógrafo a un valor de f-120 mm y Bx 215 mm.

Se encontró que las imágenes SKYLAB sirven para la restitución fotogramétrica planimétrica a escalas medianas. Con la cantidad de detalles que contienen las imágenes se pueden usar aproximaciones para estudios catastrales. No obstante, la utilización está marginada por la falta de restitución en las áreas urbanas.

* * *

GUATEMALA

UTILIZATION OF SKYLAB IMAGERY
IN PHOTOGRAMMETRIC RESTITUTION

ABSTRACT

Map sheet No. 2058 IV of Esquintla at a scale of 1:50,000 covering 500 square kilometers was used in this experiment, which was limited to planimetry. A stereoscopic pair of 9" x 9" black and white SL4, S190B images were used on a Wild A-8 Aviograph and adequate restitution was attained by setting the Aviograph with value of f-120 mm and Bx-215 mm.

It was found that SKYLAB imagery is useable for planimetric photogrammetric restitution at medium scales. With the amount of detail contained in the imagery, approximations can be used in cadastral studies. However, utilization is limited due to lack of resolution in urban areas.

PARAGUAY

PLANIMETRIC MAP

SCALE OF 1:100,000

CONCEPCION, PARAGUAY

CO-INVESTIGATOR: BG ABRAHAM ABED

PRESENTED BY: Major Ramon SANCHEZ

This planimetric map of the Concepcion area, Paraguay, was the first sheet to be produced in Latin America from SKYLAB photography utilizing photogrammetric procedures. Although it was prepared as a part of the DMA-IAGS-EROS SKYLAB experiment 496B, the final map is a valuable product in an area not previously mapped at large scales.

The photography used was SL-3 190-A, Roll 35, Frames 87-88, Camera Station 5, design band width .6 to .7, Pan-X, aerial black and white, type SO-022 film. Photography from Camera 5 was selected because of the approximation in tonal response to convencional panchromatic aerial photography.

The 70 mm negative received from NASA was enlarged two times to and approximate scale of 1:500,000 and a physical size of 140 mm for use in the Wild A-9. Using a gear ratio of 1:4, an approximate scale of 1:100,000 on the plotting table was obtained. Since control positions were not available at time of compilation, a definite scale was not possible.

The stereo pair was oriented in the Wild A-9 and level approximated using the average terrain elevation and drainage. Because the area contains terrain difference of less than 100 meters, the model should be level within ± 50 meters resulting in a near orthographic projection free of distorting camera tilts.

Compilation of the sheet was supported by field classification dated 1971. With the exception of landmark buildings and road data so indicated in the legend, no additional information was added that could not be seen on the SKYLAB model.

Control for the sheet consisted of seven first order traverse stations and two SMC picture points. Since complete control identifications and the coordinates were not available at time of compilation, it was necessary to identify control without the aid of plotted positions. The compilation was then rectified to the plotted control resulting in a precise orientation to three first order traverse stations (shown on the map) and the two SMC points.

After rectification, a negative was made of the compilation and scribe guidelines were prepared for culture, drainage, projection and grid. The SKYLAB photography was rectified to the compilation to provide photographic image background for the final map. Type

was added and the map printed using the conventional three-color lithographic method.

Street patterns were depicted to illustrate and emphasize the amount of detail which can be seen on a stereo model of satellite photography having an original scale of 1:3,000,000. The map symbolization departs somewhat from the national map standards (Paraguay) concerning road classification. This departure was done to expedite production and is clarified in the legend.

CONCLUSION

This product is evidence that mapping can be done using SKYLAB photography. The relationship of the amount of area covered to the number of man hours is impressive for SKYLAB photography. To cover this area of 960 square miles using SKYLAB photography, 25% of the one stereo model used, required a total of 36 man hours in compilation; whereas, to accomplish a similar type compilation of the same area using 1:60,000 scale photography, would require 50 stereo models and 250 man hours.

Although only two years had elapsed since the field classification of the area was completed, changes in cultural features were apparent. An example is the new road which appears along the north central edge of the sheet.

The amount of detail which is visible also makes SKYLAB photography a valuable tool for map revision using conventional photo lab and photogrammetric equipment available in most Latin American mapping agencies.

As co-investigator, the Instituto Geografico Militar (IGM), Paraguay, established the field control and performed the field classification surveys required for this experiment.

PARAGUAY

CONCEPCION

SHEET 5474

Scale 1:100,000

TRANSVERSE MERCATOR PROJECTION

HORIZONTAL DATUM: CHUA ASTRO DATUM

LEGEND

DMA-IAGS-EROS SKYLAB EXPERIMENT 4968

CONCEPCION, PARAGUAY

PARAGUAY

MAPA PLANIMETRICO

ABSTRACTO

Este mapa planimétrico de Concepción, Paraguay ha sido el primero producido en Latinoamérica mediante imágenes SKYLAB utilizando procedimientos fotogramétricos. Es un producto valioso en un área que carecía de cartografía a escala grande. En el Wild A-9 se orientó un par estereoscópico de cuadros del S190A, blanco y negro, de la cámara 5 de la misión SL3. La recopilación de la hoja se hizo a base de datos de clasificación de campo de 1971. Aparte de los edificios de referencia y datos viales que se indican en la leyenda, no se le agregó ninguna otra información que no fuera visible en el modelo SKYLAB. Se representaron los patrones viales para ilustrar y recalcar la cantidad de detalle visible en un modelo estereoscópico de fotografía de satélite a escala original de 1:3,000,000.

Este mapa demuestra que la cartografía sí es posible mediante imágenes SKYLAB y que hay un gran ahorro en tiempo y equipo en comparación con las técnicas cartográficas convencionales.

* * *

PARAGUAY

PLANIMETRIC MAP

ABSTRACT

This planimetric map of the Concepcion area, Paraguay, was the first sheet to be produced in Latin America from SKYLAB photography utilizing photogrammetric procedures. It is a valuable product in an area not previously mapped at large scales. A stereo pair of black and white S190A frames, camera 5, from the SL3 mission were oriented in the Wild A-9. Compilation of the sheet was supported by field classification dated 1971. With the exception of landmark buildings and road data so indicated in the legend, no additional information was added that could not be seen on the SKYLAB model. Street patterns were depicted to illustrate and emphasize the amount of detail which can be seen on a stereo model of satellite photography having an original scale of 1:3,000,000.

This map is evidence that mapping can be done using SKYLAB photography with great savings of time and equipment compared with conventional mapping techniques.

V E N E Z U E L A

CARTOGRAPHIC APPLICATION OF ERTS-1 (LANDSAT-1)

AND

SKYLAB ORBITAL IMAGERY

CO-INVESTIGATOR: DR. ADOLFO ROMERO

PRESENTED BY: RAFAEL LAIRET

INTRODUCTION

I - CHARACTERISTICS OF ERTS-1 (LANDSAT-1) AND SKYLAB IMAGERY

II - AVAILABLE MATERIAL

III - CARTOGRAPHIC QUALITY OF ERTS-1 (LANDSAT-1) AND SKYLAB IMAGERY

IV - TECHNIQUES

V - CONCLUSIÓNS

INTRODUCTION

The utilization of ERTS-1 and SKYLAB imagery to construct and update maps at medium and small scales (1:100,000 and 1:1,000,000) was established as a progrqm of the Remote Sensing Section of the Chart Division of the National Cartographic Direction, following tests performed during the ERTS-1 VEN-02 Program in the northern Amazon region.

Complementing this program with the measurement of first order points by geodetic satellites in the Amazon territory, a program was established for the preparation of controlled photomaps at scales of 1:250,000 to 1:1,000,000 of all the areas containing high quality material.

The results obtained show the feasibility of using ERTS-1 and SKYLAB imagery for preparing and updating maps at scales of 1:100,000 or smaller.

I - CHARACTERISTICS OF ERTS-1 (LANDSAT-1) AND SKYLAB IMAGERY

Of the equipment aboard the ERTS-1 satellite, only data from the MSS (Multispectral Scanner) were received.

The MSS is a linear scanning system whose exploring instrument is an oscillating mirror which scans just below the satellite, perpendicularly to the flight direction.

It collects data simultaneously in four spectral bands in the visible region from 0.5 to 1.1 μ. Bands 5 and 7 were used in the preparation of black and white photomaps, and bands 4, 5 and 7 for color prints.

The field of vision (IFOV) for each scanner is of 79 meters on the ground. The scanner makes 474 meter swaths along its path every 73.2 milliseconds -- the six sensors can scan 185 kms in approximately 3 seconds.

Generally speaking, according to the NDPF, the sources of error can be classified as follows:

1. External errors

2. Internal errors

3. Processing errors

Each of these erros can affect the position accuracy as well as the registraiton, or both.

As a result of compensating the internal and external errors of the sensor, according to NASA information, an error of approximately 1053 meters is produced in images entering the NDPF.

At the NDPF or Data Processing Center, imagery is processed to obtain the material which is later sent to the principal investigators.

The errors resulting from the processing produce mean square error values for bulk MSS imagery as follows:

(**) Position accuracy on the map:

Film products	1.075 m.
Paper products	1.085 m
Registration accuracy	155 m

The precision products prepared in the NDPF using known ground points produce mean square errors (according to NASA) of:

Positions accuracy on the map:

Film products	235 m
Paper products	250 m
Registration accuracy	150 m

The material received is formed by 3rd generation, 70 mm positive images with average errors equivalent to those cited in Table (**).

In the mapping work performed with ERTS-1 imagery, errors were first taken from the bulk products distributed to the principal investigators by the Goddard Space Flight Center.

In the VEN-02 Program, controlled photomosaics were prepared by rectification, but experience showed that the errors existing in ERTS-1 imagery can be corrected using identifiable first-order points, correcting only the scale of the imagery.

In a program between the National Cartographic Direction (MOP) and the Inter American Geodetic Survey (DMA), the use of SKYLAB imagery was established using data from the S190A and S190B experiments.

The first set of equipment consisted of six 70 mm cameras and the second one of one 5"x 5" metric camera. SKYLAB missions 3 and 4 took scenes of Venezuela, and although only a few were cloud-free, the scenes obtained were of excellent quality.

II - AVAILABLE MATERIAL

The basic material for the cartographic program consists of:

Maps at a scale of 1:100,000

Maps at a scale of 1:250,000

Maps at a scale of 1:500,000

Second order astronomical points

First order triangulation points

Geoceiver points

ERTS imagery

SKYLAB imagery

III - CARTOGRAPHIC QUALITY OF ERTS-1 (LANDSAT-1) AND SKYLAB IMAGERY

In order to evaluate ERTS-1 and SKYLAB imagery for cartographic purposes, the following characteristics were analyzed: position, accuracy, resolution, distances and cartographic precision.

Position: The position errors were computed by the following procedures:

Geographical grids were drawn over the ERTS imagery and the coordinates of the identifiable control points were computed; with these values, the position error of the bulk images could be determined.

For the S190A and S190B SKYLAB photography, no position errors were computed because they provide no reference values.

Resolution: According to NASA, the minimum detectable area for the ERTS-1 MSS System is 6.241 M2, or approximately 1/2 hectare (IFOV).

During the investigation program, analysis were made to establish the precision levels for object definition in ERTS-1 imagery.

Two factors were taken into account:

1. Object size, and
2. Object tonal response with relation to the surrounding media.

As is well known, the object size influences the detecting quality of the sensor. Objects less than 79 meters are difficult to define, unless the tonal contrast with relation to the surrounding media is very noticeable.

Likewise, contrast is very significant for object identification. Some objects larger than 79 meters are difficult to detect on account of the low contrast of the surrounding media. The first experiments were made with imagery of Los Testigos Archipelago, which allowed to test the detecting quality of the imagery.

In the VEN-02 Project, the best test features for object identification quality were airports, cultivated areas, highways and small tree grouping with dimensions close to the resolution limit (see example).

The airports selected for sampling were Puerto Ayacucho, Yutaje and Manipiare, each of them with fairly similar dimensions and constructed in areas with different tonal characteristics.

Tonal measurements and analysis were made in the MSS bands 5 and 7.

Highways and roads were subject to the same analysis as airports. With regard to the tree groupings and the cultivated areas, band 5 was utilized as it provides better vegetation definition.

Also, measurements and computations were made over color compositions.

The resolution for SKYLAB photography obtained from the S190A and S190B experiments depends directly on the quality of the film used. It was observed that color film normally had a higher level of resolution in the SKYLAB experiment.

Black and white photography in the different spectral bands provided excellent resolution, however, somewhat less than color film.

The problem of photographic quality in the S190A experiment determined that only bands A5 and A6, of the S190A and S190B photography, without cloud coverage could be used.

Distances: Distances are the most important test elements as they allow more accurate imagery scale control during the rectification process. Control points provided by geoceivers and first order triangulation were used to compute the distances. The procedure applied was the following:

Given that LANSAT-1 and SKYLAB images are nearly orthogonic projections of the earth surface, distance computations were made using the trigonometric formula. The differences between ground and image distances ranged from 70 to 150 meters.

The aforementioned procedure was applied to SKYLAB photography with small variations, as they act as central projections with aerial photography characteristic distortions. For a better comparison, ERTS and SKYLAB imagery were used, as well as maps at a scale of 1:100,000 of the same area (see example).

Cartographic Precision: To check the cartographic precision, the image and map overlay technique was used, both in the same scale. In the first phase non-rectified images were used, followed then by rectified images.

In general, magery coincides fairly well with the map data; only in the cases of Rivers Meta, Orinoco and the Mitare Delta, coincidence is difficult, due to changes, especially in the riverbed sand accummulations and the sand along the river banks and along the area of the Mitare Delta.

In areas of little or no change, coincidence is perfect.

For maps at scale of 1:250,000 or smaller, the ERTS-1 imagery data is priceless from the planimetric and the thematic viewpoints.

SKYLAB photography allows updating of maps at a scale of 1:100,000 and revision of urban maps at a scale of 1:50,000 basically using S190B photography, quality permitting.

Topographic Maps, Photomaps and Thematic Maps

Utilization of ERTS-1 imagery for the preparation of topographic maps poses a series of important aspects, such as:

1. Scale selection

2. Imagery processing

3. Reproduction - Publication

Scale Selection: According to experience in the ERTS-1 VEN-02 Program, the scale of 1:500,000 was selected as optimum for the preparation of photomaps. For publication and basic work of topographic and thematic maps, the scale of 1:250,000 was selected.

For the preparation of photomaps, the scale of 1:500,000 was selected due to the problems encountered in the photographic processing of originals, which had resulted in loss of details and contrast.

The procedure applied to the imagery was the following:

Imagery Processing: In the preparation of semi-controlled photomaps, only the scale was corrected using control points; for the preparation of the controlled mosaics, the normal rectification process was followed. The latter process is not necessary in all cases, since after scale correction ERTS imagery is within the acceptable margin of error.

For reproduction and subsequent publication the most adequate materials were selected, among them the half-tone screen.

150 and 300-line per inch screens were used for black and white prints and 150-line per inch screens, for color reproduction. These screens were selected to maintain the detail level in the reproduction, close to the level of resolution of the multi-spectral system.

Width of swath per sensor: 79 m.

Total swath per sensor, per image: 2.341,7

Imagery ground coverage: Approx 185 Km

For scale 1:500,000: 1 mm - 5 Kms

Image length for 1:500,000: 37 cms

For screen 133 l/inch (52,36 l/cms)

1 line = 0,19 mm

For 1:500,000 1 line = 95 m. approx

For screen 150 l/inch (59.05 l/cms)

1 line = 0,16 mm

For 1:500,000 1 line = 80 m. approx

From this it can be seen that for a scale of 1:500,000 the 150 per inch screen allows printing contours close to the resolution level of ERTS imagery.

IV - TECHNIQUES

The techniques used in the cartographic application of LANDSAT and SKYLAB imagery were the following:

1. Photographic Techniques:

    a. Enlargement

    b. Rectification

2. Compilation of basic data

3. Printing

- - - - - -

1) Compilation of basic data was done by two methods:

- By direct extraction from the image, overlaying the map at the same scale over the image.

- The other method used was the Zoom Transfer Scope.

2) The printing process was done by the same conventional method of topographic maps and photomaps preparation, the first one using line negatives, and the second one using half-tone negatives.

V - CONCLUSIONS

The results obtained in the Projects of Los Testigos, Lago de Valencia, ERTS-1 VEN-02; Map 6250 1:100,00 (Coro) and Map 1:2,000,000 of Venezuela show the feasibility of establishing an ambitious cartographic program utilizing LANDSAT and SKYLAB imagery.

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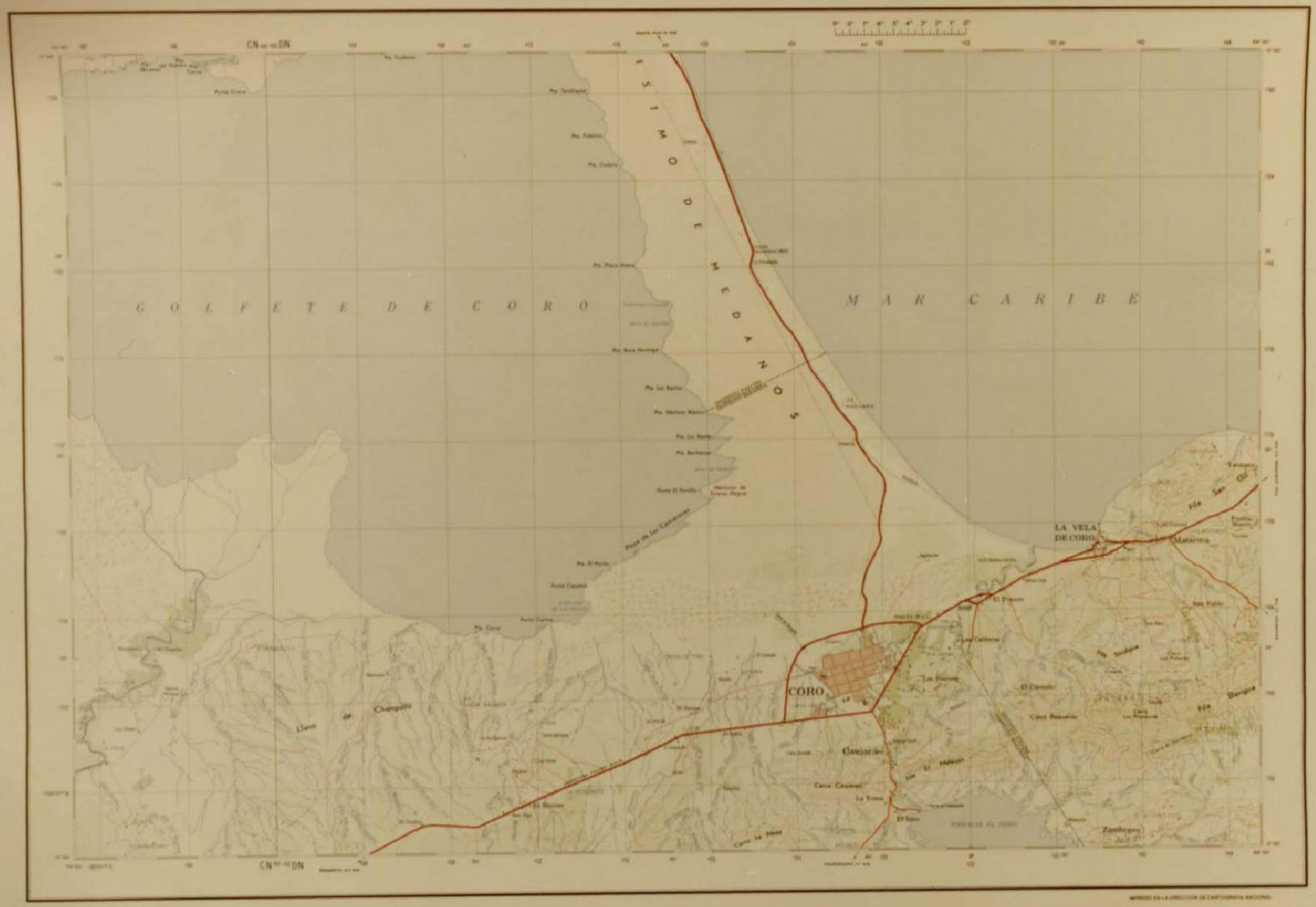
REPUBLICA DE VENEZUELA
MINISTERIO DE OBRAS PUBLICAS
DIRECCION DE CARTOGRAFIA NACIONAL

CORO

EDICION 2-DCN
1974

LA REFERENCIA DE ESTE MAPA ES:
HOJA 6250



Escala 1:100.000

CURVAS DE NIVEL A INTERVALOS DE 40 METROS
SUPLEMENTARIAS A INTERVALOS DE 20 METROS

PROYECCION MERCATOR TRANSVERSAL

HOJA 6250
CORO, VENEZUELA

VENEZUELA

ABSTRACTO

Para actualizar este mapa a escala de 1:100,000 de Coro, se usó fotografía de SKYLAB 4, S190A, cámara 5, aplicándose técnicas de rectificatión/ampliación fotográfica convencionales. Los detalles se trazaron sobre un calco transparente que posteriormente se usó para grabar los originales cartográficos. Los resultados obtenidos demuestran la factibilidad de emplear imagenes SKYLAB para la actualización de mapas a escalas de 1 100,000 o menor y lo cual ha encaminado a la Dirección de Cartografía Nacional a proyectar un programa cartográfico ambicioso utilizando las imágenes SKYLAB disponibles.

* * *

VENEZUELA

ABSTRACT

Photography from SKYLAB 4, S190A, camera 5 was used for updating this 1:100,000 scale map of Coro. Conventional photographic enlargement-rectification techniques were applied. The details were then drafted on a transparent overlay which was later used to etch the cartographic originals. The results obtained show the feasibility of using SKYLAB imagery for updating maps at scales of 1:100,000 or smaller and have led the DCN to plan an ambitious cartographic program utilizing the available SKYLAB imagery.

SOLAR INERTIAL EXPERIMENT

P A R A G U A Y

JOINT CARTOGRAPHIC INVESTIGATION

CO-INVESTIGATOR: MAJOR RAMON SANCHEZ, PARAGUAY ARMY
PREPARED BY: IGM-PARAGUAY / NASA-JSC

PARAGUAY

JOINT CARTOGRAPHIC INVESTIGATION

INTRODUCTION

The map sheets that we are demonstrating to you today are the result of a joint cartographic investigation between the IGM of Paraugay, the IAGS and NASA/JSC, Houston, Texas. These map sheets are at a scale of 1:100,000 with a 100 meter contour interval. What makes them unique is that they were photogrammetrically prepared from obliquely convergent S190A and S190B photography, obtained from SKYLAB, 435 kilometers above the earth's surface. The purpose of this presentation is to provide a brief overview of this effort and a synposis of its current status. A detailed technical report will be prepared at the conclusion of the project.

BACKGROUND

The advent of SKYLAB with cameras among its array of remote sensors logically suggested this investigation into the use of space photography as a new tool for mapping. A tool for "Cartographers" to use in their efforts to try to keep up with the many mapping requirements needed to manage and develop our world resources.

SKYLAB PHOTOGRAPHY vs CONVENTIONAL PHOTOGRAPHY

Advantages of Space Photography

The fundamental advantages of employing photography from orbital altitudes in mapping stem from the greatly increased area of coverage.

In the case of SKYLAB for example, a single S190B frame covers an area equivalent to that of approximately 250 conventional aircraft photographs flown at 9800 meters. As a result, many of the fundamental steps in map making are significantly reduced. In particular, both the amount of surveying on the ground and the number of stereoscopic models are greatly reduced. This translates into a considerable advantage economically as well as in the time required to map an area.

Description of SKYLAB Cameras and Coverage

The S190A is made up of a bank of six individual cameras with a 152 mm focal length and a format of 57 mm x 57 mm. Each individual vertical scene covers 163 sq. kms, at a scale of 1:2,900,000 from a nominal orbit altitude of 435 km. Resolution ranges from 20 to 120 meters based on film type and wavelength caracteristics.

The S190B (Earth Terrain Camera) is a 457 mm focal length camera with a 114 mm x 114 mm image format, each individual vertical scene covers an area of about 109 sq. kms. at a scale of 1:950,000 from the nominal orbit altitude. System resolution is about 10 to 15 meters using high definition black and white EK 3414 film.

Key Problem Areas

From a photogrammetric point of view, the same space photograph that provides the extended area of coverage in turn creates several technical obstacles. Basically these obstacles stem from the small B/H ratio that exists when such photography is taken in the vertical mode. Because of the small B/H ratio, vertical space photography is completely unreasonable for cartographic applications when vertical information must be derived. Another problem is the requirement for versatile analytical type plotters for restitution of the space photography. These instruments are excessively expensive, but are required to accommodate the unconventional focal lengths and, as discussed later, large amounts of tip and tilt in the photograph. Another problem is the requirement for very sophisticated and complex software and computer facilities required to perform the analytical triangulation.

Many of these problem areas were considered in the original planning of this project. To compensate for small B/H ratio of photography, convergent photography was obtained which provided a B/H ratio greater than one (1). The restitution problem was solved by the availability of an AS-11B1 analytical plotter capable of handling photography with disparate focal lengths and large convergencies. The complex software and computer facilities were also available. Many of these same problems were met and dealt with during the lunar mapping programs. One major problem is that in the lunar program we never had to worry about somebody field-checking any of our maps as we plan to do with the Paraguay map sheets.

Project Description and Current Status

The original project had been planned whereby more than 70 percent of the country of Paraguay would have been photographed with convergent stereo-photography. This proved to be overly ambitious and, because of mission constraints and cloudy weather, useful convergent photography was only obtained in the southern part of Paraguay as indicated in this slide # ____. Additional photography was obtained, but only the convergent photography in the South is being used for mapping. The strip of S190B photography falling along the eastern border of Paraguay will be utilized to prepare a 1:500,000 scale mosaic which is presently 50 percent complete.

The area in which these map sheets were compiled was covered by a strip of S190A and a strip of S190B The S190B was taken from an adjacent ascending orbit looking SE covering the same area as the S190A photography, giving excellent stereo-convergent photography of approximately 50,000 square kilometers. The scale of the photography is approximately 1:1,000,000 for the S190B and 1:3,000,000 for the S190A. The same area covered by conventional aircraft photography flown at 9800 meters would require approximately 1000 photographs comprising some 16 flight lines of 66 frames each.

Triangulation

To establish a control network, a rigorous simultaneous analytical triangulation was performed on the 19-photo two strip block of S190A and S190B photography. Only about ten well-distributed control points were minimally required to accomplish the triangulation, however, because of availability 40 control points were actually used. Ten of these points were from IAGS/IGM triangulation, where the remaining 30 were derived from existing map sheets.

This control was of varied origin and spread over such a vast area that it fell on three different horizontal datums. Before a triangulation could be attempted, it was necessary to transform all control to a common datum. A version of a computational program designed as PLODS (Photogrammetric Lunar Orbital Data-Reduction System), modified for earth use, was employed to accomplish the triangulation. In addition to simultaneously solving for exposure station locations, photo orientations and pass point coordinates, PLODS confines the exposure stations of each pass to lie on an orbital arc, situations which physically occurred during acquisition of the photography.

The root mean square of the photo measurement observational residuals resulting from the triangulation was 8 micrometers. A detailed error analysis on the accuracy of the triangulation pass points, is presently incomplete and will be forthcoming.

Compilation

The map manuscripts were compiled on the AS11B1 analytical plotter. This instrument has as an integral part a general purpose computer which automatically assists in model orientations, producing a highly accurate mathematical model. The instrument is very versatile, it will accommodate images up to a 9" x 18" format and focal lengths from 20 mm upward.

In the restitution of the models used to form the map sheets you saw earlier, frames of S190A and frames S190B were oriented on the instrument to form the Stereo models. The absolute orientations of these models has been excellent. For most cases, the RMS values of the vector residuals in photo-coordinates has been around 7 to 9 micrometers. In all cases so far the models have set to the triangulated control excellently. In the plotting of the planimetry no problems were encountered. The only limitations being the resolution of the system. The plotting of the contours was somewhat more difficult due to the flatness of the terrain and again the resolution of the system. In areas of relief the ability of the operator to place the floating mark on the ground improved significantly. In the areas where there was little relief, a series of spot heights were dropped throughout the model and a combination of logical contouring and stereo contouring was employed.

The IAGS and the IGM in Paraguay are performing the final edit, scribing and reproductions of the final map sheets. The status of the mapping project is indicated on this slide.

CONCLUSION

The camera systems flown on SKYLAB were primarily designed for remote sensing applications and are less than optimal for mapping purposes. Nonetheless, the feasibility of mapping from space photography has been clearly demonstrated. In addition, insight has been gained which will doubtless prove valuable in recommending improvements for future space mapping systems.

PARAGUAY

HERNANDARIAS

HOJA 5970

Escala 1:100.000

PROYECCION TRANSVERSA DE MERCATOR

SIGNOS CONVENCIONALES

IGM - IAGS - NASA - EROS

HERNANDARIAS, PARAGUAY

PARAGUAY

INVESTIGACION CARTOGRAFICA CONJUNTA

ABSTRACTO

Esta hoja cartográfica es una de seis obtenidas como resultado de una investigación cartográfica conjunta entre el IGM de Paraguay, el IAGS y la NASA/JSC de Houston, Texas. La hoja cartográfica está a una escala de 1:100,000 con intervalos de curvas de nivel de 100 metros. Es un producto singular porque fue preparada forogramétricamente usando fotografía SKYLAB convergente oblícua S190A y S190B. Para establecer una red de control se efectuó triangulación analitica simultánea estricta en los bloques de cinco fajas de fotografías de S190A y S190B. Los manuscritos cartográficos se recopilaron en el trazador analítico analítico AS-11B1. El IAGS y el IGM realizaron la edición el grabado y las reproducciones de la hoja cartográfica final. La factibilidad de levantar mapas mediante fotografías espaciales ha quedado claramente demostrada a través de este experimento.

* * *

PARAGUAY

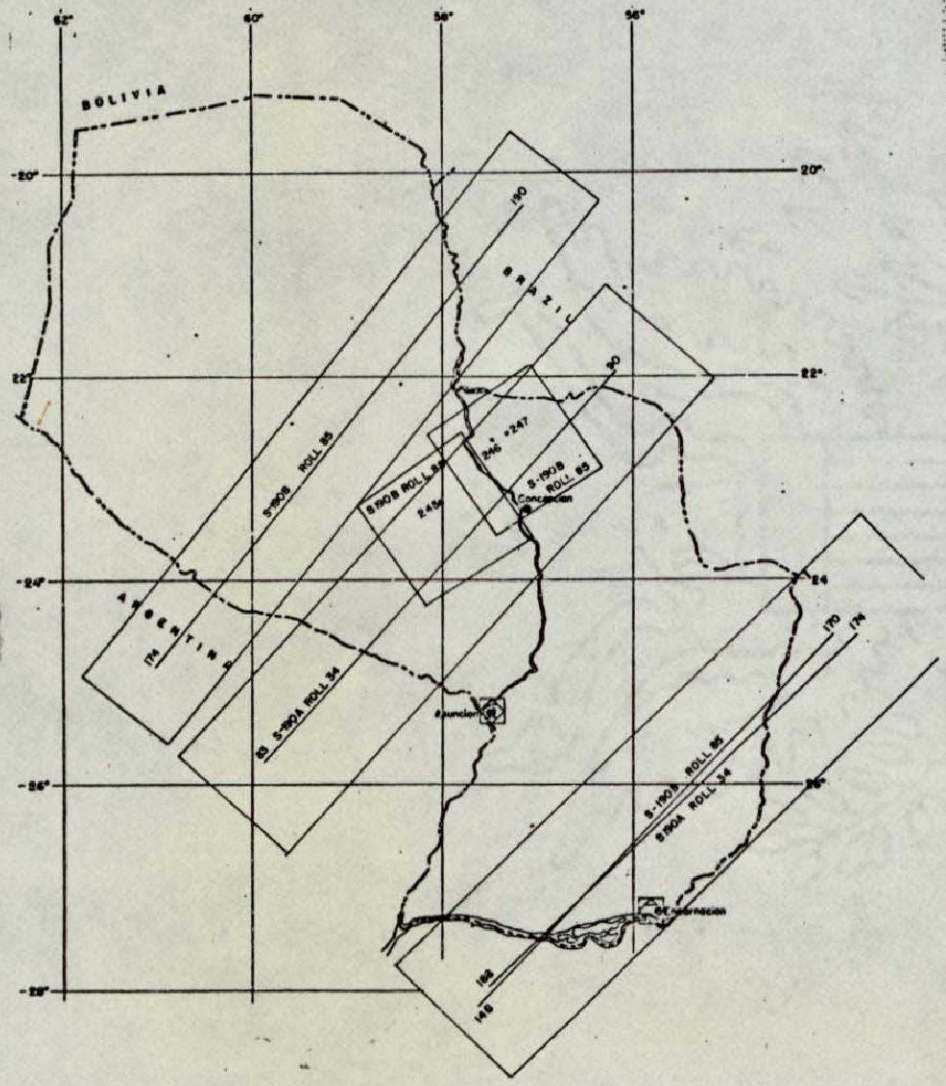
JOINT CARTOGRAPHIC INVESTIGATION

ABSTRACT

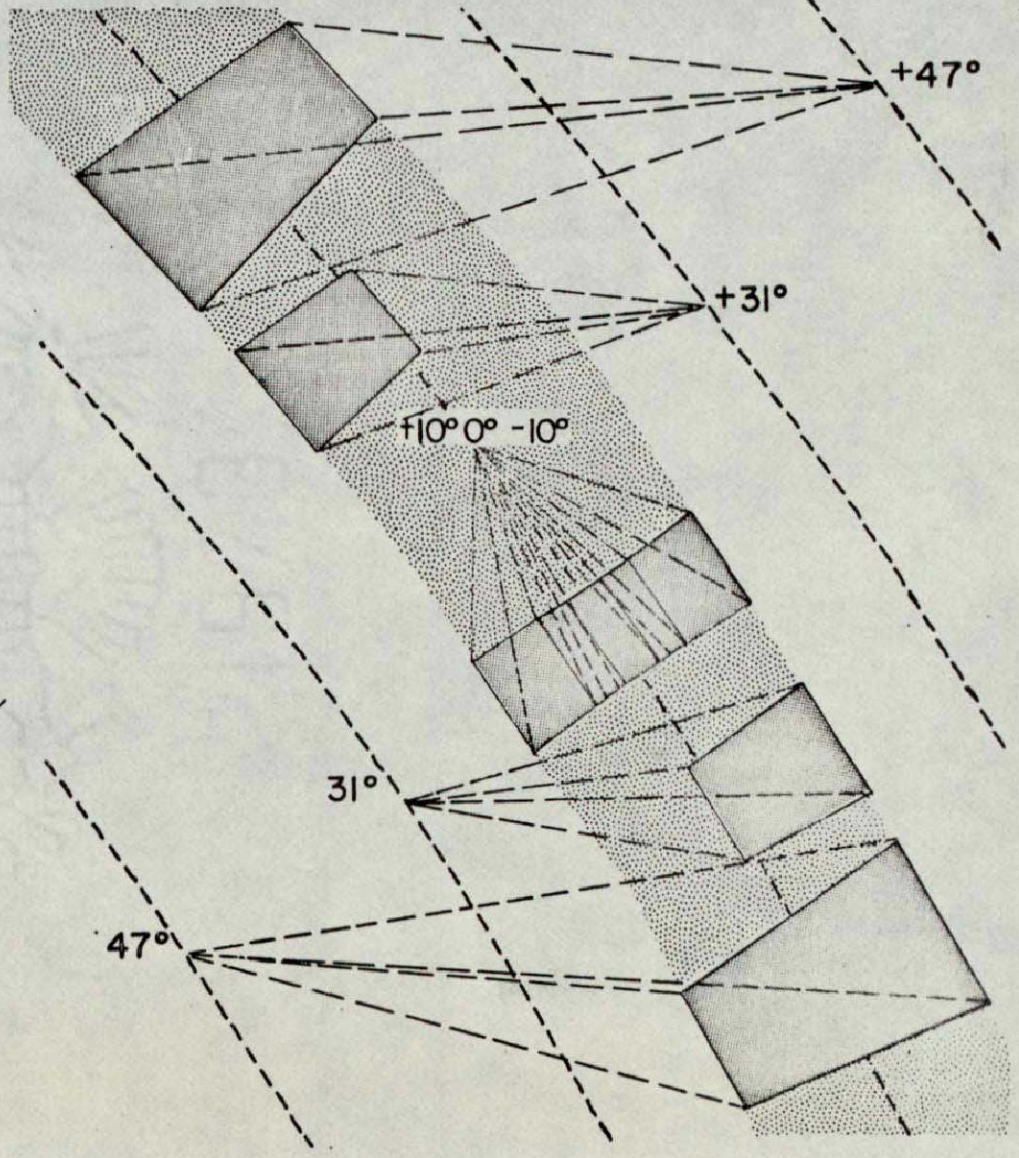
This map sheet is one of six resulting from a joint cartographic investigation with IGM Paraguay, IAGS and NASA/JSC Houston, Texas. The map sheet is at a scale of 1:100,000 with a 100 meter contour interval. It is unique because it was photogrammetrically prepared from obliquely convergent S190A and S190B SKYLAB photography. To establish a central network, a rigorous simultaneous analytical triangulation was performed on a five strip blocks of S190A and S190B photography. The map manuscripts were compiled on the AS11B1 analytical plotter. IAGS and IGM performed the final edit, scribing and reproductions of the final map sheet. The feasibility of mapping from space photography has been clearly demonstrated by this experiment.

C-2

SL-3 SOLAR INERTIAL EXPERIMENT COVERAGE OF PARAGUAY



THE BASE HEIGHT RATIO FOR THE 47° OBLIQUE PHOTOGRAPHY



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SOLAR INERTIAL EXPERIMENT CONTROL POINT IDENTIFICATION

AERIAL PHOTOGRAPH

SKYLAB S2 S190A PHOTOGRAPH

SKYLAB S190B PHOTOGRAPH

INVESTIGATORS CONFERENCE ON THE

LATIN AMERICAN SKYLAB EXPERIMENT.

PARTICIPANTS AT THE SKYLAB CONFERENCE

COUNTRY	PARTICIPANTS
Bolivia	BG Oscar Wilde Fernández, Director, IGM
Chile	LTC José Mutis Puccio, Director, IGM MAJ Víctor Oddo, Director, Cartography, IGM
Colombia	Dr. Rodolfo Llinas, Chief, Carto Section
Costa Rica	Ing. Mario Barrantes Ferrero, Director Dr. Rodolfo Quirós Guardia, Pres. Advisor
Dominican Republic	Ing. José Joaquín Hungría Morell
Ecuador	CPT José Herrera
El Salvador	Roberto López Meyer, Sub-Director, IGN
Guatemala	Ing. Sergio Vargas
Honduras	Ing. Fernando Lanza Sandoval, Director Raúl Andino Torres
Nicaragua	Ing. Guillermo Navarro
Panama	Lic. Julio A. Molo, IGNTC Lic. Miriam Branford
Paraguay	MAJ Ramón Sánchez
Peru	COL Oscar de Lama Loro, Sub-Director
Venezuela	Lic. Rafael Lairet Lic. Luis Arista
OEA	Ing. Miguel Petit Ayala
U.S. Geological Survey	Frederick Doyle
NASA	Rigdon Joosten
IAGS	COL John W. Park Jack E. Staples Norman Fassett Susan B. Robinson

AGENDA

SKYLAB LATIN AMERICAN CARTOGRAPHIC EXPERIMENT

CO-INVESTIGATORS CONFERENCE

DATE: June 25, 26, and 27, 1975

PLACE: DMA IAGS Cartographic School (Remote Sensing Classroom), Bldg. 127, Fort Clayton, Canal Zone

Date	Time	
24th (Tuesday)		Arrival of Participants
25th (Wednesday)	0900	Welcome - COL John W. Park, Jr., Director, DMA IAGS
	0915	Remarks on Skylab Experiment Introduction of Participants Mr. Jack Staples, Principal Investigator
	0930	Administrative Details EROS Distribution Center Ms Susan Robinson, Chief, IAGS-EROS Distribution Center
	0945	Latin American Co-Investigators Products Presentations Argentina - Mr. Staples Bolivia - BG Oscar Wilde Fernández Chile - LTC José Mutis Puccio Colombia - Dr. Rodolfo Llinas
	1200	Lunch Sandwiches and drinks served at conference
	1300	Latin American Co-Investigators Products Presentations Costa Rica - Ing. Mario Barrantes Ferrero Dominican Republic - Ing. José Joaquín Hungría Morell
	1400 - 1530	USGS Cartographic Applications of Skylab Imagery Mr. Fred Doyle
	1900 - 2100	Welcoming Cocktail Party Quarry Heights Officers' Club (Casual dress)

Date	Time	
26th (Thursday)	0900	Zoom Transferscope Demonstration Mr. Larry Goldstein
	0930	Latin American Co-Investigators Products Presentation Guatemala - Ing. Sergio Vargas Nicaragua - Ing. Guillermo Navarro Panama - Lic. Julio Molo Paraguay - MAJ Ramon Sanchez Venezuela - Lic. Rafael Lairet
	1200	Lunch
	1330	Joint NASA, IAGS, IGM Paraguay Solar Inertial Experiment MAJ Ramon Sanchez
	1400 - 1530	NASA Presentation Mr. Rigdon Joosten
	1600 - 1730	Tour of Miraflores Locks
	1730	Travel to Pedro Miguel Las Cruces Launch Ramp (transportation by sponsors)
	1800 - 2000	Las Cruces Launch Partial Transit of Canal Drinks will be served aboard the boat (casual dress)
27th (Friday)	0900	Roundtable Discussion Participants
	1200	Lunch
	1330	Additional time for Roundtable Discussion Approval by Participants of Conclusions of Experiment
	1500	Concluding Remarks COL John W. Park, Jr.
	1900 - 2030	Cocktails COL Park's home, Qtrs. 85, Ft. Clayton, C.Z.
	2100	Dinner Amador Officers' Club, Room of the Americas (business suit)
28th (Saturday)		Depart Canal Zone

SKYLAB

CONCLUSIONS AND RECOMMENDATIONS

I. INTRODUCTION.

To date the work performed has been prepared over areas with basic cartography, at a scale of 1:50,000 and 1:100,000 as a means of comparison. Areas where no control nor cartography existed could not be evaluated.

Due to climatic conditions, the SKYLAB imagery obtained covers areas which have aerophotogrammetric coverage.

1. General.

a. Multi purpose manned missions are not an appropriate way to collect useful cartographic photography. Constraints on orbit altitude, inclination, lifetime, and operational sequence, dictated by the requirements to keep the crew alive and return them to Earth, are not compatible with efficient photographic coverage.

b. The narrow angle photographic systems represented by S-190A and S-190B do not have appropriate geometry (Base - height ratio) for compilation of topographic maps.

c. Due to climatic conditions, the SKYLAB imagery obtained covers areas which have aerophotogrammetric coverage.

2. S-190 Multi Spectral Camera System.

a. The scale and ground resolution of this photography are adequate for photographic reproduction at scale 1:250,000, but not for interpretation of all the necessary map information.

b. The high resolution black-and-white panchromatic photography is more useful for mosaic preparation and interpretation than the black-and-white infrared, color, or color infrared photography.

3. S-190B High Resolution Camera System.

a. The scale and resolution of this photography are adequate for photographic reproduction at scale 1:100,000, but the 10 - 15 meter resolution is not sufficient for interpretation and classification of all details on the planimetric map.

b. Given the choice between high resolution black-and-white film, or lower resolution color or color infrared film, the higher resolution black-and-white film is preferred for cartography.

c. Color film is useful over very arid areas, but in most areas of the world, atmospheric conditions result in blue photographs with very little useful color rendition. Color infrared film is preferred for haze penetration and useful color information.

4. S-192 Multi Spectral Scanner

There is as yet no basis for evaluating the cartographic utility of S-192 data.

II. RECOMMENDATIONS.

1. Continue with the program.

2. That the Inter American Geodetic Survey continue with the distribution of SKYLAB imagery and expand its services, to include advisory and the enlargement of negatives to a more adequate scale, with the object of implementing the maximum utility of these images for those countries which lack sufficient technical means for the adequate photographic manipulation of the negatives.

3. Determine the limitations of the program. On many occasions, the capabilities of the system are exagerated which leads to confusion and false information (being disseminated) to the users.


RECEIVED
NASA STI FACILITY
INPUT BRANCH