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Produced by the NASA Center for Aerospace Information (CASI)
EREP REPORT

a. Defense Mapping Agency Inter American Geodetic Survey
   Drawer 934
   Fort Clayton, Canal Zone

b. Overall Evaluation of Skylab Imagery for Mapping of Latin America

c. Progress Report, 1 August 1973 through 28 February 1974

d. EREP Investigation Number 496B

e. NASA Contract Number T-4651B

f. Principal Investigator - Jack E. Staples

g. 1 March 1974

h. Technical Monitor:

   Mr. Roger D. Hicks
   Mail Code TF6
   Telephone Number 713 483 6451
(3) **Other Activities**

(a) Ground truth measurements were made over Lake Titicaca, Bolivia, on 27 January and 1 February 1974 at the request of Johnson Space Center, NASA, Earth Resources Program Office.

(b) To date, I have not experimented with the S192 data to prepare thematic maps because no data has been received. This has not seriously affected the experiment because we have instead concentrated on familiarizing the Co-Investigators with the S190A and B imagery that is available.

(4) **Problem Areas.** To date there have been no significant problems encountered although there is a lack of essentially cloud-free imagery over the Co-Investigators' areas. This restricts executing the experiment to a few countries.

b. **Recommendations.** I hope that Skylab 4 has produced cloud-free imagery of more of the Latin American countries so the experiment can be extended to include more of these Co-Investigators. To date, there is no black and white 190B imagery over our areas of interest - all that has been received to date is in color, cloud covered, or over Brazil. Black and white photography is necessary for producing mapping. It is hoped that we do receive some black and white 190B with the shipment of SL4 so I may further proceed with the experiment.

c. **Expected Accomplishments:**

(1) The Skylab Experimentation Team will be working with Bolivia and Chile during March 1974 through June 1974 to use both S190A and B imagery to produce map revision products and new mapping at 1:100,000 - 1:50,600 scales.

(2) Work will continue on the experiment to use solar inertial and earth oriented imagery in Paraguay to produce a 1:100,000 scale, 10 meter contour interval, topographic map. This will be accomplished in conjunction with Johnson Space Center Earth Resources Program Office. It is expected that a member of that office will be visiting IAGS and Paraguay in April 1974 to discuss the operational aspects of this experiment.

(3) When S192 data is received, IAGS will be working with USGS to initiate a thematic mapping experiment.

d. **Significant Results.** The two experiments clearly demonstrate the practical application of the Skylab photography to update existing maps.
at an optimum scale of 1:100,000. The photography can even be used, by employing first order photogrammetric instruments, for updating the cultural features in 1:50,000 scale mapping. The S190A imagery has also shown itself to be most economical in preparing new photomap products over previously unmapped areas, such as Concepcion, Paraguay. These maps indicate that Skylab quality imagery is invaluable to the Latin American cartographers in their efforts to provide the mapping products required to develop their countries. In Latin America, where over 5,000 people are employed in map production and where the Latin American Governments are expending over $20 million in this effort, the use of such systems to maintain existing mapping and publish new mapping over previously unmapped areas, is of great economic value and could release the conventional Latin American mapping resources to be utilized to produce large scale 1:25,000 and 1:1,000 scale mapping that is needed for specific development projects.

e. Summary Outlook. The experiment has proceeded as predicted and I expect to meet the established deadlines.

f. Travel Summary. The Skylab Experimentation Team will be traveling to both Bolivia and Chile from March through June this year. I also expect a visit from a member of the JSC Earth Resources Program Office in April and expect to travel with him to Paraguay.

3 Enclosures a/s

JACK E. STAPLES
Principal Investigator
Experiment 496B
PROGRESS REPORT

1 August 1973 through 28 February 1974


a. Overall Status

(1) Receipt of Material. S190A imagery from Skylab 2 was received in August 1973 and 190B received during September 1973; Skylab 3 190A imagery was received in December 1973 and 190B in January 1974. Enclosures 1 and 2 are graphical depictions of the imagery received to date. Two copies of the imagery were received to date. Two copies of the imagery were received; one copy was sent to the Co-Investigators.

(2) Progress to Date:

(a) Skylab Experimentation Team was created and Mr. Robert A. Patton and Mr. Jesse N. Valle, DMA IAGS, were selected as members of that team.

(b) Geoceiver positions in Paraguay were completed. Copies of imagery of the solar inertial passes over Paraguay were received in January 1974. Photo-identified positions have been selected on the photography and are being returned to Johnson Space Center for analytical aerial triangulation adjustment.

(c) Review and processing of imagery. The imagery was received, processed and reviewed. Two areas were selected for initial experimentation. These were Santa Cruz, Bolivia, and Concepcion, Paraguay. From these, the Cartographic Team prepared two cartographic products.

1. A map revision of a 1:50,000 scale sheet No. 6940-I covering Santa Cruz, Bolivia (explanation of process and sample of sheet attached as Enclosure 3).

2. A 1:100,000 scale enhanced photomosaic of Concepcion, Paraguay (Enclosure 3).

Both the above products will be forwarded to Mr. Rigdon Joosten of Johnson Space Center, NASA, who will present them at the meeting of the American Society of Photogrammetry in St. Louis, Missouri, in March 1974.
SKYLAB IMAGES RECEIVED

IAGS - ERGS INFORMATION
and
DISTRIBUTION CENTER

190 A

LATIN AMERICA

- SL-2
- SL-3
- SL-4
DEFENSE MAPPING AGENCY
INTER AMERICAN GEODETIC SURVEY
USGS EROS PROGRAM
SKYLAB EXPERIMENT 496B

° PLANIOMETRIC MAP — CONCEPCION, PARAGUAY
30MINUTE QUADRANGLE, 1:100,000 SCALE

° MAP REVISION OVERPRINT — SANTA CRUZ, BOLIVIA 1:50,000

° SKYLAB PHOTO ENLARGEMENT WITH TOPOGRAPHIC MAP OVERLAY
SANTA CRUZ, BOLIVIA 1:100,000 SCALE
MAP REVISION, OVERPRINT, SANTA CRUZ, BOLIVIA, 1:50,000 SHEET 69401

This experimental map revision overprint of the 1:50,000 scale Santa Cruz sheet is 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-022 film. Photography from Camera 5 was selected because of the approximation in tonal response to conventional pan-chromatic aerial photography.

The 70 mm negative received from NASA was enlarged two times to an approximate scale of 1:1,500,000 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.

**SKYLAB PHOTO ENLARGEMENTS WITH TOPOGRAPHIC MAP OVERLAY**

The purpose of this product is to give the viewer a visible comparison between the current topographic map published in 1972 and a SKYLAB photo taken in 1973. The topographic map, although published in 1972, utilized photography taken over the years from 1956 to 1969. The SKYLAB 2 photograph was taken in June 1973 and enlarged from 1:3,000,000 to 1:100,000 scale and reproduced by Ozalid methods. The 1:100,000 scale topographic map overlay is a reduction of the 1:50,000 scale topographic map and was also reproduced by Ozalid methods.

**CONCLUSION**

This experiment is evidence that SKYLAB photography provides an economical and rapid means of accomplishing initial planimetric mapping and map revision. Such satellite photography and imagery can substantially assist Latin American nations in obtaining and maintaining, in an economical manner, those map products needed for development.

Comments about this product and its potential value will be appreciated. Please address them to:

DMA Inter American Geodetic Survey
ATTN: IAGS-EROS Coordinator
Drawer 934
Fort, Clayton, Canal Zone
LEGEND
SIGNOS CONVENCIONALES

On this map a lane is considered as being a minimum of 2.5 meters wide.
En este mapa se considera que una vía tiene un ancho mínimo de 2.5 metros.

Red tint represents built-up areas in which only important buildings are shown.
El tinte rojo representa zonas urbanizadas en las cuales solo se muestran edificios importantes.

GLOSARIO
GLOSSARY
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 maps 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
SUPPLEMENTARIAS A 10 Y 5 METROS
VERTICAL DATUM: MEAN SEA LEVEL

TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: PROVISIONAL SOUTH AMERICAN DATUM OF 1956

BLACK NUMBERED LINES INDICATE THE 1,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 20, INTERNATIONAL SPHEROID
LAS LÍNEAS NEGROS NUMERADAS INDICAN LA CUADRÍCULA UNIVERSAL TRANSVERSA DE MERCATOR A 1,000 METROS, ZONA 20, ESFEROIDE INTERNACIONAL

 USERS ARE URGED TO REFER CORRECTIONS AND COMMENTS FOR INCREASING THE USEFULNESS OF THIS MAP TO COMMANDING GENERAL, U.S. ARMY TOPOGRAPHIC COMMAND, WASHINGTON, D.C. 20315
TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH SUBTRACT G-M ANGLE

PARA CONVERTIR UN AZIMUT MAGNÉTICO A UN AZIMUT DE CUADRICULA RESTESE EL ÁNGULO C-M

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH ADD G-M ANGLE

PARA CONVERTIR UN AZIMUT DE CUADRICULA A UN AZIMUT MAGNÉTICO SUMESE EL ÁNGULO C-M

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH SUBTRACT G-M ANGLE

PARA CONVERTIR UN AZIMUT DE CUADRICULA A UN AZIMUT MAGNÉTICO RESTESE EL ÁNGULO C-M

TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH ADD G-M ANGLE

PARA CONVERTIR UN AZIMUT MAGNÉTICO A UN AZIMUT DE CUADRICULA SUMESE EL ÁNGULO C-M
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<th>Translation</th>
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<tr>
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<td>drainage ditch</td>
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<tr>
<td>Cárceles</td>
<td>jail</td>
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<td>Catedral</td>
<td>cathedral</td>
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<tr>
<td>Cerámica</td>
<td>ceramic factory</td>
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<tr>
<td>C-convencional</td>
<td>circumferential highway</td>
</tr>
<tr>
<td>Colegio</td>
<td>school</td>
</tr>
<tr>
<td>Colegio militar de aviación</td>
<td>military aviation school</td>
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<td>gas company</td>
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<td>Convexo</td>
<td>cementery</td>
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<td>pumping station</td>
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<td>Hacienda</td>
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<td>Ministry of Agriculture</td>
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<td>landing strip</td>
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<tr>
<td>Planta de agua potable</td>
<td>filtration plant</td>
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<tr>
<td>Planta de algodón</td>
<td>cotton plantation</td>
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<tr>
<td>Puesto militar</td>
<td>military post</td>
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<tr>
<td>Quebrada</td>
<td>stream</td>
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<tr>
<td>Río</td>
<td>stream</td>
</tr>
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<tr>
<td>Tel.</td>
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<tr>
<td>Templo</td>
<td>temple</td>
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<tr>
<td>Universidad</td>
<td>university</td>
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<tr>
<td>Vado</td>
<td>ford</td>
</tr>
</tbody>
</table>

**ADJOINING SHEETS**

- 694 III
- 694 II
- 704 III
- 694 IV
- 694 I
- 704 IV
- 694 III
- 694 II
- 704 III
PLANEFIGRIG MAP, CONCEPCION, PARAGUAY. 1:100,000 SCALE

This planimetric map of the Concepcion area, Paraguay, is 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-FROS 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 conventional panchromatic aerial photography.

The 70 mm negative received from NASA was enlarged two times to an approximate scale of 1:1,500,000 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 the 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 have 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.

Comments about this product and its potential value will be appreciated. Please address them to:

DMA Inter American Geodetic Survey
ATTN: IAGS-EROS Coordinator
Drawer 934
Fort Clayton, Canal Zone
Prepared by the IAGS-EROS team in the Panama Canal Zone, February 1974 as an initial photogrammetric experiment with SKYLAB photography (camera S190A Station 51) taken September 1973. Planimetric map features compiled by photogrammetric methods (WILD A9). Road classification and landmark features were extracted from 1:50,000 field classification data 1971. Authorization for use and distribution of this map was approved by the Paraguayan Government, February 1974.
Scale 1:100,000

TRANSVERSE MERCATOR PROJECTION

HORIZONTAL DATUM: CHUA ASTRO DATUM

NUMBERED LINES INDICATE THE 2000 M UTM Grid Zone, International Spheroid Zone 21
Legend:

- Fair or dry weather roads
- Improved, loose or light surface two lanes wide
- Unimproved, Dirt
- (Extracted from field classification data)
- Cart track, Trail
- (Extracted from field classification data)
- Church, School

CONCEPCION, PARAGUAY