

## LANDSAT MOSAIC OF THE MEXICAN REPUBLIC

by

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## ABSTRACT

Landsat Mosaic of the Mexican Republic in infrared color, was made with 135 scenes of Landsat Satellite, which cover the 2 million square kilometers of the country.

This mosaic was the base, for "the first Cartographic Project" of its kind for one entire country, and consists of making 31 states maps and one map of the Mexican Republic each one containing the plans of the Mexican Government for Urban Development to the 2000 year and Natural Resources of the Nation.

This project is an example of collaboration among several agencies: U.S. Geological Survey, Photo Sciences, Inc., from U.S.A., and Secretaria de Asentamientos Humanos y Obras Publicas, IPESA Consultores, S.C. from Mexico, and describes how this Cartographic project was developed and how the maps were produced

## INTRODUCTION

The first use of Landsat images in Mexico utilized only one of the four multispectral bands obtained by the remote sensors of the satellite. Thus the first mosaics of Mexico using these images were produced in black and white.

In 1977 the General Electric Laboratory in collaboration with NASA produced the first Landsat mosaic of the Republic at a scale of 1:4,300,000, using color-infrared film. Both mosaics were made from the best prints obtainable without regard to an overall density standard which resulted in tonal differences between one and another scene that were very notable, detracting from the mosaic's use and beauty.

The need for better quality Landsat images to make mosaics, with better graphic as well as geometric resolution obviously required an investigation into other methods of obtaining such copy.

When the Directorate for planning of SAHOP an agency of the Government of Mexico contracted our Company IPESA Consultores, S.C. to prepare a series of state maps to show the 20 year plan for development of new agricultural areas and resettlement of people we determined to use the Landsat Multispectral Sensor (MSS) images for these maps.

The Directorate and IPESA approached the U.S. Geological Survey in 1980 seeking information of the best methodology to produce the Landsat base. In 1981 work on a mosaic was initiated by Photo Science Inc. of Gaithersburg together with IPESA and technical advice provided by the Graphic Research Unit of the U.S. Geological Survey. The 32 maps were printed in 1982 by the U.S. Geological Survey.

I believe that these maps are the first produced using Landsat color imagery for an entire country for use as a base for a physiographic study and development plan. However, though the mosaics are a step up from the earlier mosaics cited they do not match the graphic quality of those prepared by use of image correction and enhancement techniques. We considered these techniques and deemed them too costly for our purpose because of the digital programs on which they depend. Furthermore, our initial review of the lists available at the EROS Data Center indicated that the quality of the scenes available and percentage of cloud free coverage for the south of Mexico was poor. See fig. 1.

The maps that you can see displayed are thus a compromise but have served us well and we plan to make more detailed studies of water basins and selected areas for soil studies and agriculture. On those studies we will make use of Landsat imagery digitally enhanced.

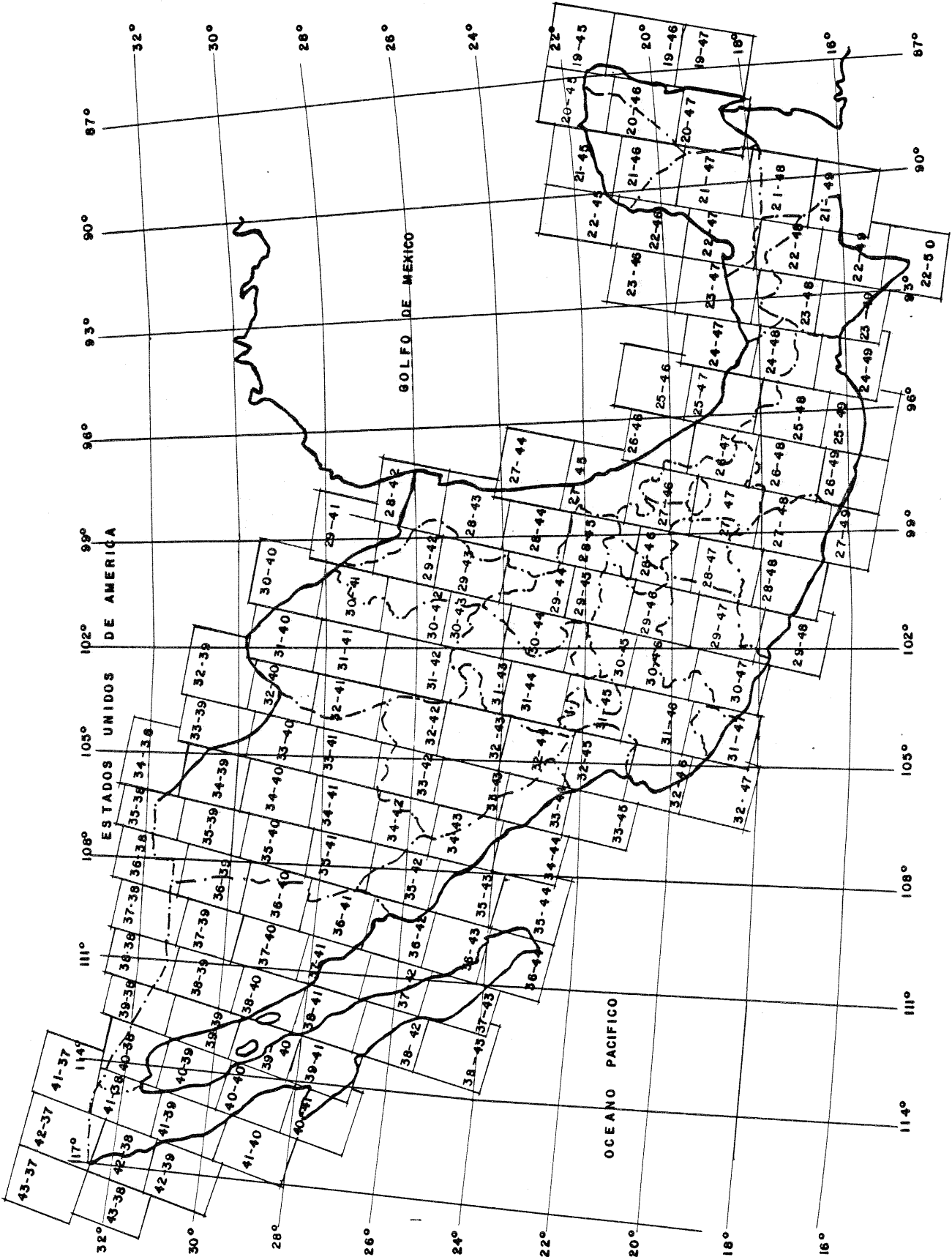
#### THE ELABORATION OF THE LANDSAT MOSAIC OF THE REPUBLIC OF MEXICO

To prepare the mosaic a selection was made at the EROS Data Center at Sioux Falls, South Dakota of the best available images from the 135 scenes covering the Republic. Having made this selection separate film positives of bands 4, 5 and 7 were made of each scene taking special care to obtain a reading of .7 on the midtone of the 15 step Stouffer scale used as a control.

This target had been determined previously by the USGS Graphic Research Unit to be the most favorable to give the best results in subsequent camera enlargements and processing of plates for lithographic reproduction.

To make the mosaic base, band 7 was chosen because that band gives the best definition of the land surface, facilitating visual adjustment to map points selected for control. The maps used for this control were the Operational Navigation Chart (ONC) series at scale 1:1,000,000 produced by the U.S. Defense Mapping Agency Aerospace Center (DMAAC).

To facilitate handling in the laboratory the country was divided into 8 sections, 1.50 x 1.20 meters. The division and format of the sections were dictated by the size of film and the location and relative size and scale of the 31 states.



LANDSAT INDEX

FIG. 1

The steps taken to prepare the mosaic started with making a laydown of the band 7 scenes for each section by placing a transparent stable film or carrier sheet over a mylar film mosaic of the ONC charts and positioning and fitting each image as well as possible to the physiographic detail shown on the charts. Fig. 2a.

The initial laydown being completed and taped to the carrier sheet, fiducial marks for each scene were point pricked and a fine contact line scribed on a scribe coat previously stud registered to the base, carrier sheet and peel cotes for subsequent processing steps. Fig. 2b.

This contact line was scribed in the overlap areas of the scenes and represented for each scene the area of least clouds, and best quality of images. The contactline scribe cote was used to prepare the red film peelcotes in the contact frame. This contactline "burned" onto 4 peelcotes was used to open windows in a checker board fashion. Fig. 2c-f.

The images are placed on their corresponding peelcote and exposure window and registered precisely by means of the fiducial marks previously pin-pricked.

Each of the 4 peelcotes with their images taped firmly in place are then exposed in sequence over a sheet of virgin film to complete the mosaic for that one section and one band as a black and white continuous-tone original or master. In this manner the other 7 sections were completed for each of the 3 mss bands to render a total of 24 masters for further processing.

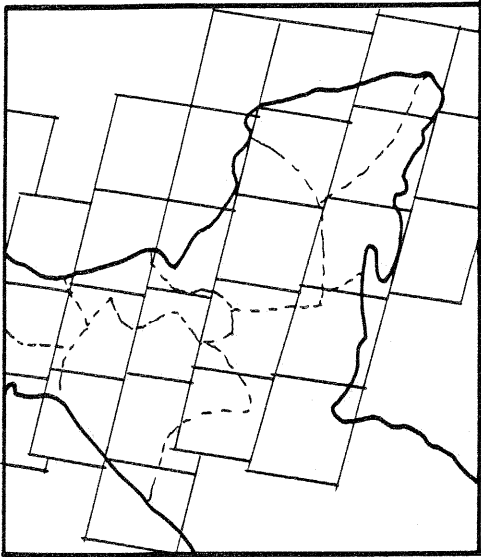
This processing was ultimately to yield color lithographic mosaics of the Landsat base with each band assigned the printing color determined by previous work to be the most suitable; yellow for band 4, magenta for band 5 and cyan for band 7.

The U.S. Geological Survey's graphic research specialists in particular Mr. Joe McSweeney's guidance based on his thorough knowledge of photographic and lithographic principles and experience permitted us to complete with a minimal correction of the tonal densities of the masters, final sets of half tone negatives at three different scales and lithographic prints with a general homogeneity of color without resorting to the computer.

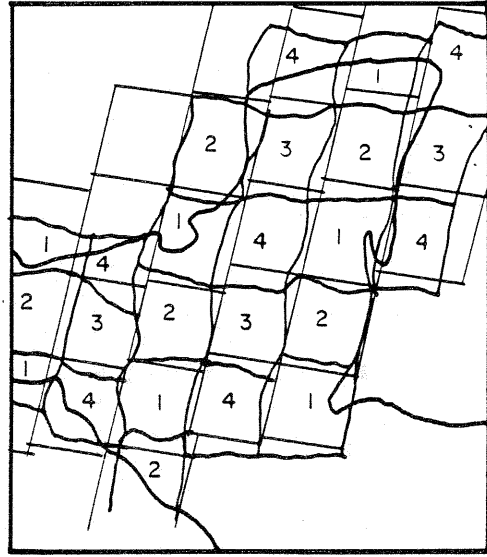
The halftone negatives of each map were all of a uniform size and format as predetermined to permit publishing a set of maps for distribution to state and local agencies and schools as well as for further planning. The federal plan for resettlement programs for each state is shown by the thematic information surprinted on the Landsat base.

#### ELABORATION OF THE THEMATIC PLAN

The thematic information shown on the Landsat mosaics as listed are the same for each state of the Republic.



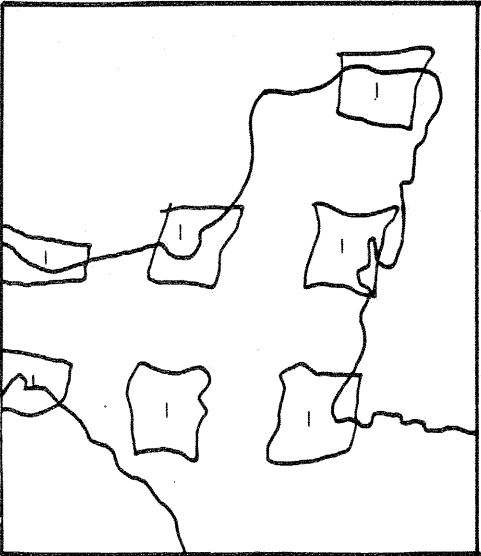
( a )



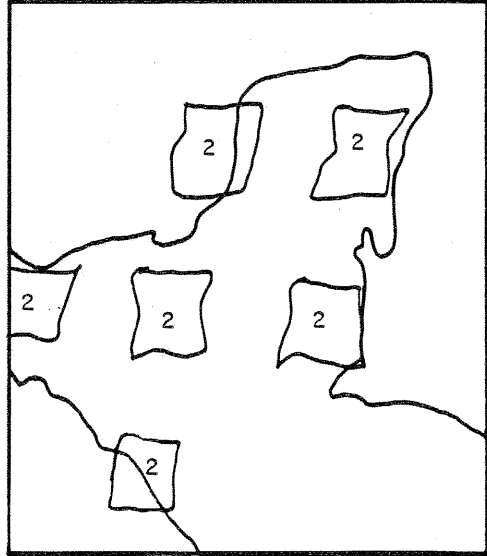
( b )

MOSAIC SHEET #8  
 IMAGES UNION OVER THE ONC  
 CARTOGRAPHIC BASE

WINDOWS SELECTION

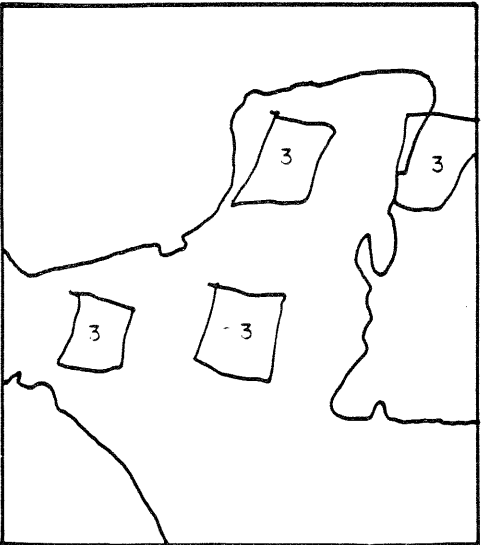


( c )

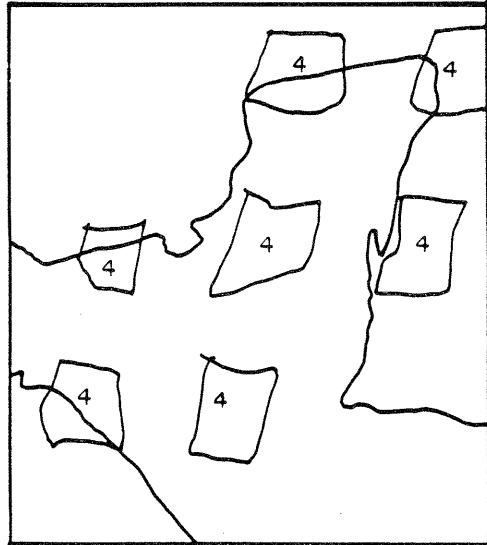


( d )

WINDOWS IN RED POLYESTER



( e )



( f )

FIG. 2

- A
- 1 System of cities proposed by the year 2000
  - 2 Present use of the land as indicated by the Landsat image
  - 3 The inter urban network of the nation
  - 4 Program of incentives for the relocation of industries from present urban centers
  - 5 Juridical Authority for the state plan for urban development
- B The sources of cartographic data for this information were:
- 1 Road maps of Secretaria de Asentamientos Humanos y Obras Publicas (SAHOP)
  - 2 State base maps
  - 3 Topographic maps of DETENAL
  - 4 Synoptic maps of SARH
- C The size of the map is 86 X 122 cms containing the Landsat image and Cartographic data within a neat line of 81 X 83 cms
- D In accordance with the 81 X 85 cms neat line and the best scale to fit the size of scale to that format the three scales chosen and the states for each scale are:

State Maps at scale 1:1,000,000.

Baja California  
Baja California Sur  
Coahuila  
Chihuahua

Durango  
Sinaloa  
Nuevo Leon  
Oaxaca

Sonora  
Tamaulipas  
Veracruz

State Maps at scale 1:500,000.

Campeche  
Chiapas  
Guanajuato  
Guerrero

Puebla  
Jalisco  
Michoacan  
Nayarit

Quintana Roo  
San Luis Potosí  
Tabasco  
Yucatán  
Zacatecas

States Maps at scale 1:250,000

Aguascalientes  
Colima  
Hidalgo

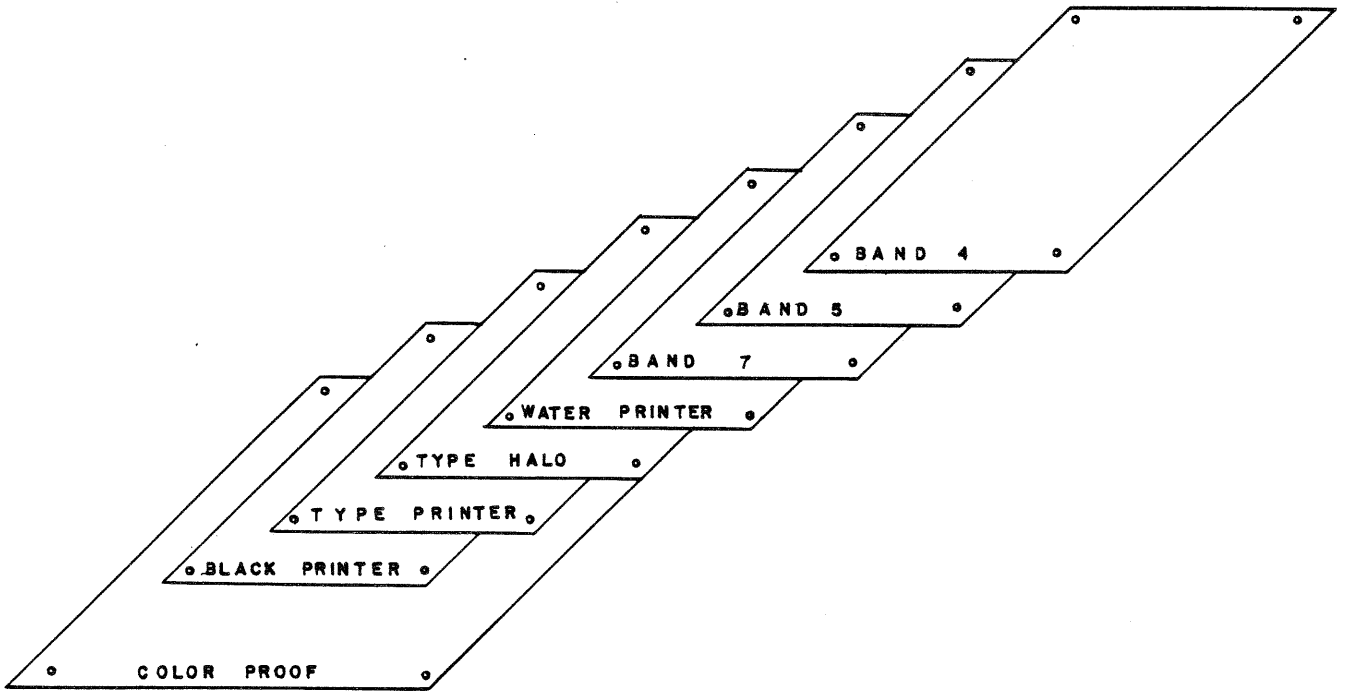
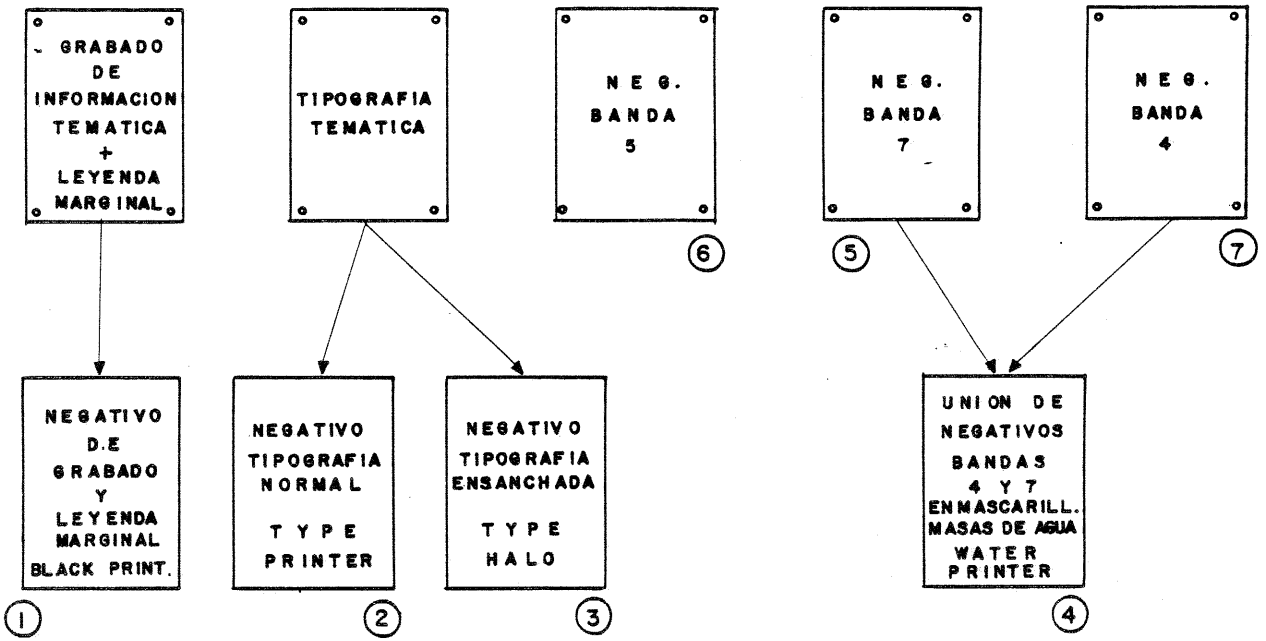
Mexico y D.F.  
Morelos

Querétaro  
Tlaxcala

Map of the Republic of Mexico

1:4,000,000

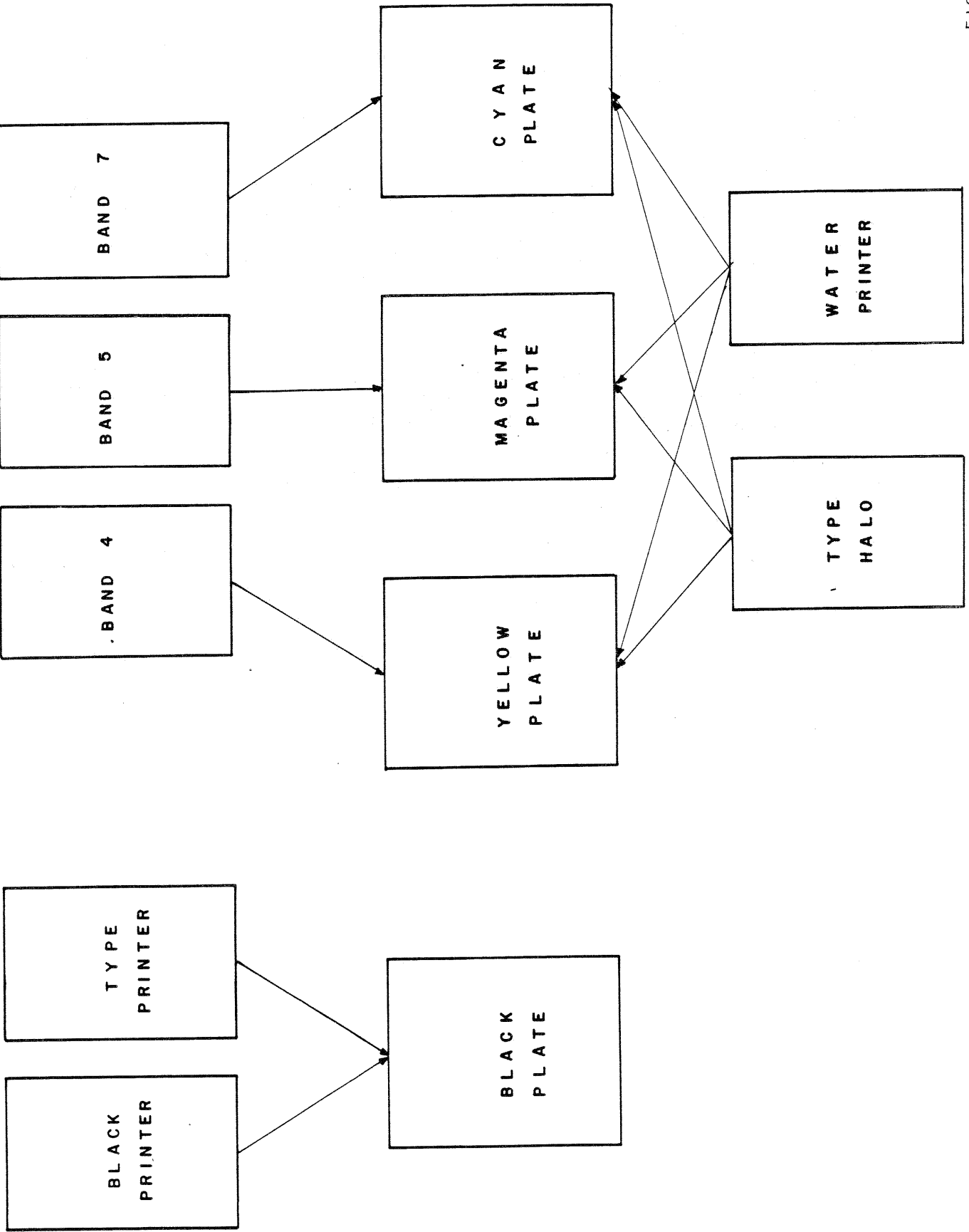
The following diagram shows how the Landsat base map for each state with its component thematic cartographic information was printed  
Fig. 3.



COLOR PROOF

FIG. 3

PRINTER PLATES





## CONCLUSIONS

The Landsat mosaic of the Republic of Mexico and the 31 state maps were -- prepared and printed in 2 years. These Landsat based maps offer our users comprehensive up-to-date information and a base for various studies that a series of line maps alone could not offer.

Although the use of the computer and electronic processors have improved the geometric and graphic quality of the Landsat mosaics considerably, we can affirm that the mosaics prepared by photo-mechanical means within a short time and at a reasonable cost are of great utility. However, we do expect to make use of the computer enhanced images of Landsat and of other satellite remote sensor imagery to come but on a limited basis, in those areas which our earth scientists decide hold the best prospects for development of water resources for increased food production.

In this era in which our country and others in various phases of development, are experiencing a severe economic crisis we cannot fail to utilize the newer computer and digital mapping technology offered by the industrial countries, but we do intend to make maximum use of simpler systems which cost less as we have done with the work here presented.