CARTOGRAPHIC APPLICATIONS OF ERTS IMAGERY

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The Department of the Interior, through the EROS Program, has developed a number of ERTS cartographic experiments. These experiments, which have been accepted by NASA, are summarized as follows:

EXPERIMENT	NASA NO.	STATUS
o Photomapping of the U.S.	211	Funded
o Map Revision	237	Funded
o Basic Thematic Mapping	116	Funded
o Polar Regions Mapping	149	Funded
o Mapping from Orbital Data	150	Funded
o Overall Cartographic Application	233	Funded
o Cartographic Application of MSS Imagery		Negotiations
o Photomapping of Foreign Areas	146	Negotiations

The principal investigators of these experiments have not, as yet, received sufficient data on which to report. However, NASA has asked Interior to take a quick look at selected ERTS-1 imagery and report thereon. The following figures indicate the results of this quick-look examination with respect to cartographic applications and cartographic products. The term cartographic, as used herein, applies to graphics that have been related to an accepted reference figure of the earth within a prescribed degree of accuracy.

NASA Order S-70243AG-2

Note that in figure 1 the term resolution is not used. With respect to photography, we believe we know how to relate image resolution to a final product. With respect to RBV's and scanners, however, we are not prepared to do this nor are we prepared to discuss the resolution of ERTS. However ERTS image quality in many respects is better than anticipated from preflight experiments. We have asked NASA to install sizeable bar targets for definitive resolution analysis. In the meantime, we are having edge analyses made but do not feel they can at this time be reliably related to resolution as conventionally recorded in terms of bar-target response. As figure 1 shows, we believe that such criteria as spectral consistency and detectability are meaningful indicators of image quality of cartographic products.

Note that figure 2 refers only to internal accuracy, but external errors must also be considered. The external errors are well known, and they vary from insignificant amounts to several hundred meters. The mapping scales shown are for optimum conditions of minimal external errors. Note the basic conflict between image quality and geometric properties. Based on image quality alone the MSS bulk (system corrected) is the one form which appears suitable for mapping at 1:250,000 scale. However, it lacks the prerequisite geometric properties which are exhibited by the precision (scene corrected) products and the RBV bulk imagery. Perhaps this means that two products are required, one for spatial accuracy and the other for (nongeometric) image quality.

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NONGEOMETRIC RELATIVE IMAGE QUALITY

FORM	SPECTRAL CONSISTENCY	OBJECT DETECTABILITY	MAXIMUM PRINTING SCALES*
RBV, BULK	POOR TO FAIR	GOOD	1:250,000-1:500,000
MSS, BULK	GOOD	GOOD	1:250,000
RBV, PRECISION	POOR TO FAIR	FAIR	1:500,000-1:1,000,000
MSS, PRECISION	FAIR TO GOOD	FAIR	1:500,000

*Estimate based on samples evaluated by the unaided human eye.

Figure 1

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GEOMETRIC PROPERTIES (PRELIMINARY)

FORM	INTERNAL ACCURACY, GROUND SCALE	MAXIMUM SCALE FOR NMAS* PRODUCTS
RBV, BULK	~70 METERS, RMS	1:250,000
MSS, BULK	>300 METERS, RMS	<1:1,000,000
RBV, PRECISION**	~50 METERS, RMS	1:250,000
MSS, PRECISION**	~50 METERS, RMS	1:250,000

* National Map Accuracy Standards

** Requires Ground Control to Produce

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Figure 2

Figures 3, 4, and 5 indicate the various scales and forms that cartographic products might take. On figure 3, note that precision-processed images, as produced by NASA, are recognized as a form of cartographic product. However, we believe such a product should be lithographed to make it generally available at reasonable cost. Note also that bulk MSS imagery may become a cartographic product by fitting a reference grid to the image. This results in a somewhat warped grid and scale changes. We recommend this procedure only as a last resort. However we do have computer programs developed to print such grids.

Figure 4 indicates that a wide range of cartographic products can be made from ERTS data, whereas figure 5 indicates what appears to be an optimum phase or goal.

Figure 6 summarizes Interior's cartographic application efforts from ERTS. For the first time, you see revision of line maps mentioned. This is an obvious application with respect to water features but also shows promise in the portrayal of vegetation and gross cultural features.

The remaining figures illustrate some of the products.

Figure 7 is of a standard NASA product. Even though the UTM zone boundary (120° long.) cuts across the image, UTM coordinates can be determined anywhere on the image with a simple coordinate reader. Geographic coordinates can also be read, but this requires considerable effort because of meridian convergence.

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CARTOGRAPHIC PRODUCTS

FIRST PHASE, PHOTOIMAGE

SCALE	1:1,000,000
FORMAT	IMAGE (185 by 185 km)
PROJECTION AND GRID	UTM
MODE	B&W AND/OR COLOR
FINAL FORM	LITHOGRAPHED

PROCESSES:

- PRECISION -- MSS OR RBV (NASA)
- BULK RBV -- SCALED AND RECTIFIED
- BULK MSS -- GRID FITTED TO IMAGE (not a defined projection)

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Figure 3

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CARTOGRAPHIC PRODUCTS

INTERMEDIATE PHASES, PHOTOIMAGE

SCALES	1:250,000 to 1:1,000,000
FORMAT	IMAGE, STATE, OR QUAD
PROJECTION AND GRID	VARIED
MODE	B&W, COLOR, OR THEMATIC
FINAL FORM	LITHOGRAPHED

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Figure 4

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CARTOGRAPHIC PRODUCTS

OPTIMUM PHASE, ORTHOPHOTOQUAD

SCALE	1:250,000
FORMAT	1° x 2° (STANDARD QUAD)
PROJECTION AND GRID	UTM
MODE	B&W AND/OR COLOR
FINAL FORM	LITHOGRAPHED

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Figure 5

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SUMMARY OF

CARTOGRAPHIC APPLICATIONS

APPLICATION	SCALE
PHOTOIMAGE PRODUCTS, B&W AND/OR COLOR	1:250,000 to 1:1,000,000
THEMATIC PRODUCTS, B&W (BINARY) (SNOW AND ICE, WATER, IR REFLECTIVE VEGETATION)	1:250,000 to 1:1,000,000
REVISION OF LINE MAPS, GROSS FEATURES	1:250,000 AND SMALLER

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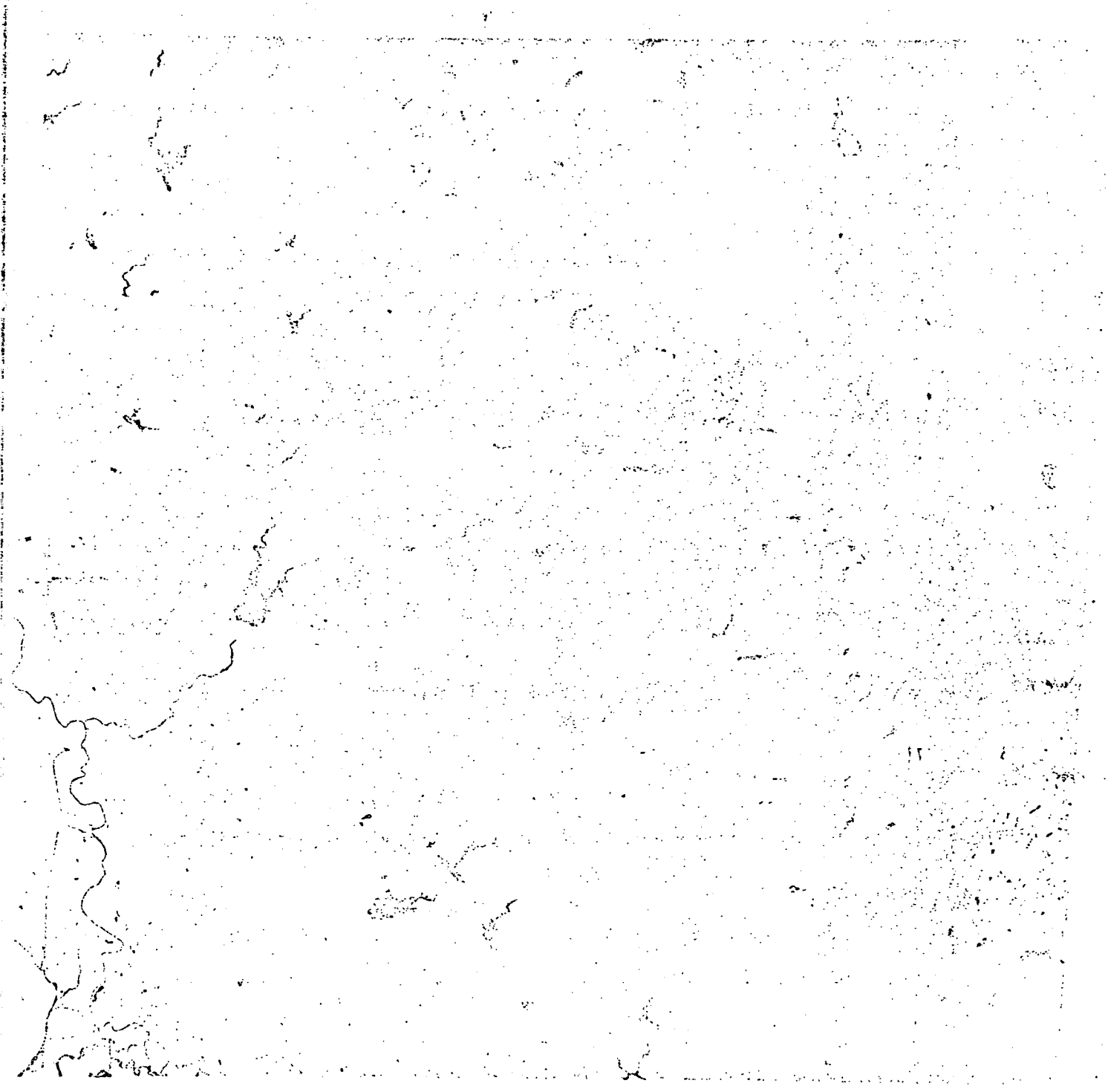
Figure 6

USA NASA ERTS I E-1002-18131- 6 -1

121° 00 120° 30 120° 00 119° 30



SCALE 1:1,000,000

UTM PROJECTION ZONE 10
POSITIONAL QUALITY
APPROXIMATE ELEV 1010 M

KILOM 0 5 10 20 30 40 50
STATUTE MI 0 5 10 15 20 25 30

IMAGED 25 JUL 72 18134519
PRECISION PROCESSED
FORMAT CENTER N38°43 W120°

Figure 8 illustrates the same scene as prepared for lithography. A full grid and explanation of the process has been added to the NASA precision-processed product.

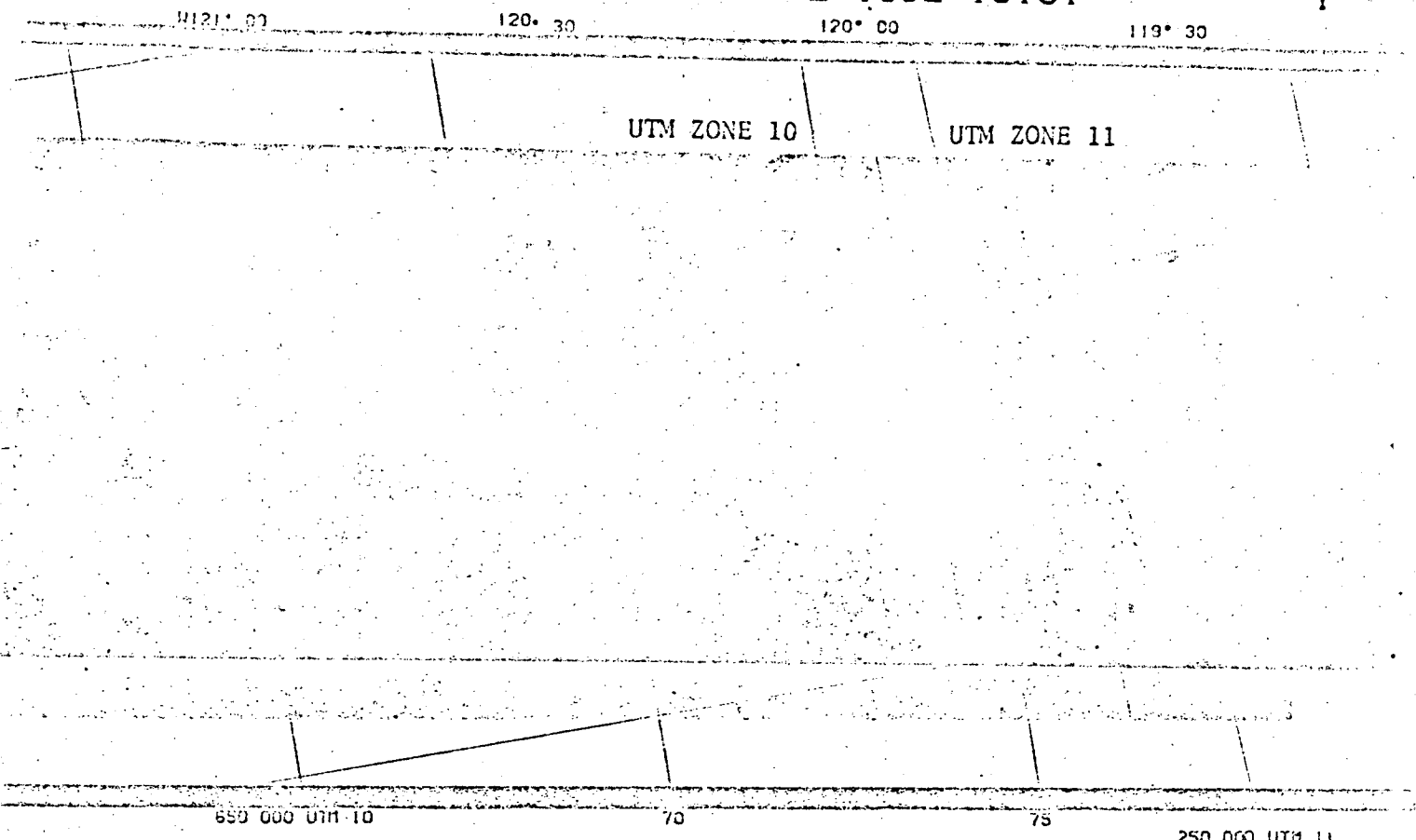
Larger scale products are difficult to illustrate, but samples of ERTS images enlarged to 1:500,000 and 1:250,000 scale are available in hard copy form for examination.

ERTS was never defined as a mapping satellite, and its ability to portray the earth in three dimensions is certainly limited. However, when one treats the Earth's surface as a series of 2-dimensional planes or maps, then ERTS-- because of its unique vantage point of 920 km altitude -- becomes a powerful mapping tool. It offers the mapmakers something they have never had -- an extensive and continuous source of up-to-date data in a form suitable for cartographic expression.

LAKE TAHOE AREA

CALIFORNIA — NEVADA

USA NASA ERTS I E-1002-18131- -1



SCALE 1:1,000,000

KILOM 0 5 10 20 30 40 50

ST MI 0 5 10 15 20 25 30

UTM PROJECTION ZONE 10
POSITIONAL QUALITY
APPROXIMATE ELEV 1010 M

IMAGED 25 JUL 72 1813:19 GMT
PRECISION PROCESSED 09 AUG 72
FORMAT CENTER N38°43.2/W120°27.6

EXPERIMENTAL ORTHOPHOTOIMAGE

THIS PRODUCT COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

This orthophotoimage was produced within 15 days of exposure on semiautomatic equipment t the NASA data processing facility. It is a cartographic product from the Earth Resources echnology Satellite. The satellite is continuously orbiting the earth and recording such cenes at an altitude of 915 km. To provide such images of the earth, sensors of varying avelengths aboard the satellite provide multiple images of each scene. Three of these ini- ial images at 1:3,360,000 scale have been precisely restituted to ground control points and nlarged to a scale of 1:1,000,000. The three images originally exposed by different spectr nds have been cartographically merged by the USGS and lithographed as a false-color compos nown geometric and radiometric errors in the initial images were removed and the cartograph uality improved. In the process the ground resolution is reduced. The square shading block re a result of the present system of precision processing.