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UNIQUE CHARACTERISTICS OF ERTS

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Aerial cameras and the photographs they produce have been increasingly applied to mapping and related studies for over 50 years. The manned spaceflights have demonstrated what film cameras can do in space and they could provide a data source from which maps would be one of the principal products. ERTS was not defined with mapping as one of its principal objectives, but with ERTS-1 in orbit certain unique characteristics or advantages of the electronic transmission (TV) Earth-sensing system become apparent to the mapmaker. (Electronic transmission from geosynchronous orbit has characteristics completely different from either ERTS or film systems. This paper does not include any comparisons with geosynchronous Earth sensing.)

Six of the more obvious advantages over aircraft and satellite film systems are as follows:

1. Long life and coverage. Even after 7 months of flying, some areas of the U.S. are still not adequately covered by ERTS for cartographic purposes. Apparently a full year will be needed to complete the coverage even though the sensor is turned on for every pass over the U.S. That a single film-return satellite could be efficiently flown for such a long period, or come anywhere near complete U.S. coverage, is doubtful in the extreme. With luck ERTS-1 may survive for 2 or more years and thus provide repetitive as well as complete coverage, making the most of only one launch, spacecraft, and instrument package.

2. Near real time. The advantage of electronic transmission in near real time is obvious even though the capability of realizing the advantages has not been fully developed. For example, a cartographic product was produced within 2 weeks after scene acquisition by ERTS. Electronic transmission of imagery has, in the past, included sizable geometric distortions. ERTS is proving that imagery can be electronically transmitted without serious distortion.

3. Orthogonality. No aerial photosystem or film-return space system (as proposed by Interior) provides imagery as near orthogonal as that of ERTS. The field of view of the ERTS MSS extends only 5.76° from the nominal vertical. The near orthogonality of ERTS imagery precludes compilation of topographic (contour) maps but simplifies small-scale planimetric mapping and revision. Since topography changes little, maintaining up-to-date planimetry is the

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major mapping problem once an area has been topographically mapped. An orthophotoquad consisting of little more than an image precisely referenced to the figure of the Earth is probably the most effective method of portraying up-to-date planimetry. ERTS imagery is ideal for small-scale orthophotoquads for two reasons. First, external errors such as relief displacement are so small that the image can be used directly, except in areas of extreme relief, without going through the complex transformation provided by an analytical plotter or an orthophotoprinter. Second, the narrow field of view means that the entire scene is being imaged with a nearly constant vertical aspect and thus provides uniform spectral response from any given element of the scene.

4. Radiometric fidelity. The ERTS signals, particularly those of the MSS, are in effect those of a focusing radiometer, recording radiated energy with a range and precision well beyond the capability of any current film system. Therefore, either on tape or as later recorded on film, the spectral image of a given scene will be more meaningful from ERTS than from any film camera. Since ERTS records four wavebands, they can be combined to provide a response optimized for particular scenes or for objects of sufficient size. Film cameras can record up to three bands on one film (color or color IR), but altering the combination for a particular scene or object is complex and imprecise. The separate band characteristic of ERTS is particularly important for mapping objects or areas that have unusual radiometric responses or that are imaged under unusual conditions of illumination, such as the polar regions.

5. Extension into the near IR wavelengths. Available aerial films cut off between 0.8 and 0.9 μm, which is about the same as for band 6 of the MSS. MSS band 7, at 0.8 to 1.1 μm, has opened a window for remote sensing for which operational film systems do not have a capability. The band is enormously powerful and has demonstrated the following unique capabilities:

a. Effective penetration of thin clouds and contrails (under certain conditions).

b. Definition of the water/land interface with high precision, enabling detection and identification of water bodies as small as 200 m diameter and determination of water stage to a fraction of a meter through boundary correlation in flat, shallow areas. The capability is particularly significant when one considers that the instantaneous field of view of the MSS (spot size) is 79 m.

c. Superior definition of vegetation patterns, largely due to the differential sensitivity of band 7 to vegetation types.

d. Superior definition of natural features. Geologists (and others) are selecting MSS 7 as the best single band for depicting the Earth's physiographic structure.

e. In some cases cultural features are best defined on band 7. For example, the pattern of major streets in Los Angeles as so far recorded by ERTS.

Aerial film systems being developed abroad cover the MSS-7 waveband.* If they become operational, the current advantage of the MSS-7 waveband will, of course, be reduced.

6. Extension into the thermal wavelengths. NIMBUS-5 and NOAA-2 are demonstrating thermal mapping with a spot size of 700 to 900 m. ERTS-B is scheduled to carry a thermal scanner of about one third this spot size, that is 240 m. Thermal mapping with a spot size of 240 m has enormous potential application and is, of course, impossible with film systems.

Today television is an accepted means of visual communications, and TV Earth sensing systems such as ERTS and its successors promise to take their place beside the film camera as essential tools for cartography.

*Information from Dr. George Zissis of the University of Michigan.