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THE USE OF PHOTOGRAPHIC METHODS IN CONTRAST ENHANCEMENT OF ERTS-1 IMAGES*

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ABSTRACT

The contrast of ERTS 70mm positive images can be enhanced to varying degrees by rephotographing the images with different types of negative films, and by overdeveloping the films with different developers. A combination of high-contrast copy film (Kodak 5069) and a high-energy developer (Kodak D-11) yields high contrast. Still greater contrast may be obtained by using a film of higher contrast capability and a developer of higher energy capability. Contrast can also be enhanced in the printing process with the use of high-contrast photographic papers, or with the use of polycontrast photographic paper and filters. Contrast enhancement by photocopying delineates topographic boundaries and may aid in the objective measurement of topographic parameters.

1. ACKNOWLEDGEMENTS

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2. INTRODUCTION AND PURPOSE

The ERTS-A Project SR-131 concerns the occurrence and morphology of dunes in many arid regions of the world, as interpreted from the appearance of these features on ERTS-1 imagery. Because sand features on ERTS images are sometimes "washed out" in the standard processing, dune patterns can often be more sharply delineated on contrast-enhanced prints made from contrast-enhanced negatives, which in turn are made from the standard ERTS 70mm positives. The boundaries between the lee and windward slopes of individual dunes are better defined on prints made from contrast-enhanced negatives than on the original ERTS positives. Sharper contrast aids in the recognition of eolian dunes, and it is hoped that it will also aid in the measurement of their morphologic parameters.

3. PROCEDURE

The ERTS positives were placed on a light table which transmits a light intensity constant in both space and time (A Laser Sciences Inc. light table, Model LT 630, was used in this study) and were rephotographed with negative film. An Asahi Pentax Spotmatic 35-mm single lens relfex camera was used because it fitted conveniently into the microscope holder of the light table. The camera was equipped with a 50-mm lens and helicoidal extension tubes for closeup photography.

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In order to determine the proper exposure, different types of negative films were exposed in grades ranging from underexposure to overexposure and were then overdeveloped. The combination of underexposure and overdevelopment results in an increase in contrast. If, as in this case, the ERTS positive does not cover the entire field of view of the camera, the remainder of the field must be blacked out to enable the light meter to determine accurate times of exposure. For example, on a test roll of Kodak Panatomic X (ASA-32), an ERTS 70mm positive was rephotographed at 1/15 second[1/] at the following apertures: The correct exposure as determined by the camera light meter "E" increased by 2 f-stops, "E", and "E" reduced by 1, 3, 5, and 7 f-stops respectively (as shown in tables 1 and 2). The test film was then overdeveloped by 50 percent. (Note: Information on developing times for film types is packaged with the film or developer. If actual temperature of the developer differs from that recommended, adjust the time-of-development according to the film data sheet, or by use of the developing computer on page 9 of the Kodak Darkroom Guide). After development, at least one and generally several of the contrast-enhanced exposures were useful for printing. For the same test roll, the best exposure was E reduced by 5 f-stops. This underexposure was representative of the degree of contrast-enhancement that could be obtained for this particular combination of film type and developer. Different test rolls were similarly exposed and overdeveloped with recommended developers (table 1). Panatomic X, Plus X Pan, and High Contrast Copy Film 5069 were overdeveloped with Kodak D-76, D-76, and DK-50 respectively. The results, summarized in table 1, indicate that the high-contrast copy film offers the greatest contrast when overdeveloped with the recommended type of developer, followed by Plus X Pan, and Panatomic X.

The same types of films were again given variable exposure, but were overdeveloped with a high-energy developer to further enhance contrast. These results are summarized in table 2. High-contrast copy film again offers the greatest contrast, followed by Panatomic X and Plus X Pan. Note the reversal in order of contrast between Panatomic X and Plus X Pan.

Table 3 combines the results of tables 1 and 2, and shows the relative degree of contrast that exists between each film and developer combination in the first two experiments. A printed photograph from the negatives for each combination of developer and film type is illustrated in figure 1. Note the increase in contrast from A to F. Figures 2, 3, and 4 illustrate contrast enhancement in photographs printed from the three Kodak film types overdeveloped in Kodak D-11. In each figure, A, B, and C represent prints made on contrast grade 3 paper from Plus X, Panatomic X, and high contrast copy film, respectively. "D" is also a print made from high-contrast copy film, but it was printed on polycontrast with a number 4 filter to further enhance contrast. In all figures the increase in contrast becomes greater from A to D. In figure 2 there is an increase in the visibility of the "patterned ground" (the white-splotched ground covering the left half of the photo),

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[1/] Shutter speed must be less than 1/60 second if 60-cycle-per-second AC current is used by the light table. For films with ASA ratings of 64 or greater, it may be necessary to use filters to reduce light input, allowing for slow shutter speeds. Recommended filters are neutral density, red, or polarizing. The latter filter can reduce glare if glass is used to hold the ERTS positive in place.

Kodak Film Type (and ASA speed)	Contrast	Best Exposure (E=proper f-stop indicated by light meter)	Kodak Developer	Recomm. Time of Dev. (68°F, small tank) (minutes)	Actual time of Dev. at 68°F, small tank (minutes)	Percent of over dev.	Filter	Shutter speed (sec.)
Panatomic X (ASA 32)	low ↑	E+5 f-stop	D-76	7	10.5	50	none	1/15
Plus X Pan (ASA 125)		E+4, 5 f-stop	D-76	6	9.0	50	red	1/30
High-contrast copy 5069 (ASA 64)	↓ high	E-1 f-stop 0 E+1 f-stop E+2 f-stop	DK-50	5	6.5	30	polarizing	1/15

Table 1. Order of contrast of three types of Kodak films overdeveloped with recommended developers and the photographic conditions under which they were exposed and developed.

Kodak Film Type	Contrast	Best Exposure (E=proper f-stop indicated by light meter)	Kodak Developer	Recomm. Time of Dev. (68°F, small tank) (minutes)	Actual Time of Dev. at 68°F, small tank (minutes)	Percent of over dev.	Filters	Shutter speed (sec.)
Plus X Pan ASA 125	low ↑ ↓ high	E+5, 7 f-stop	D-11	3.5	5.66	62	None	1/15, 1/30
Panatomic X ASA 32		E+5, 7 f-stop	D-11	3.5	5.5	57	Red	1/30
High-contrast copy 5069 ASA 64		E+3, 2, or 1 f-stop	D-11	6.0	7.5	25	Polarizing	1/15

Table 2. Order of contrast of three types of kodak films overdeveloped with a high energy developer (kodak D-11), and the photographic conditions under which they were exposed and developed. High-contrast copy film is very sensitive and several closely spaced exposures may be necessary even after a good exposure has been predetermined.

	Kodak Film Type	Developer	Percent Overdev.	Code letter in Fig. 1
Low contrast	Plus X Pan	D-76	50	A
↑	Panatomic X	D-76	50	B
	Plus X Pan	D-11	62	C
	Panatomic X	D-11	57	D
	High-contrast copy 5069	DK-50	30	E
↓ High contrast	High-contrast copy 5069	D-11	25	F

Table 3. Order of contrast of the various combinations of film and developer types listed in tables 1 and 2. Figure 1 shows variations in contrast printed from enhanced negatives made from the combinations of film and developer above.

and in the dunes in the lower left and center, from A to D. In figures 3 and 4 increases in contrast are not limited to the size of the topographic features. Although the dunes in figure 4 are very small, enhancement techniques employed here noticeably improve their visibility. If further contrast is needed, films with a higher contrast capability, as well as developers of higher energy, are available.

Further contrast enhancement may be obtained by photocopying (on a Xerox or IBM copier) 8" X 10" or larger prints of already contrast-enhanced ERTS negatives (fig. 5). The topographic features desired to be enhanced can be somewhat controlled by a simple form of density slicing (the adjustment of the light-dark copy control on the photocopying machine being used). In many instances, this process further delineates the boundaries of topographic features and may simplify the measurement of morphologic parameters (in the case of ERTS-A SR-131, dune width, length, density, crest regularity, and others (as defined by Harris, 1972, p. 29, 48).

4. CONCLUSIONS

The contrast of ERTS positive images can be enhanced to varying degrees by rephotographing the images with different types of negative films, and by overdeveloping the films with different developers. A combination of high-contrast copy film (Kodak 5069) and high-energy developer (Kodak D-11) gave the greatest contrast among those tested. Still greater contrast is obtainable by using a film with greater contrast capability and a higher energy developer. Contrast can also be enhanced in the printing process; prints can be made on higher contrast photographic papers, (grade 5 or higher), or on polycontrast paper using the appropriate filters.

Another method of contrast enhancement is photocopying 8" X 10" prints made from contrast-enhanced negatives. This further delineates topographic boundaries and may simplify the objective measurement of morphologic parameters.

5. REFERENCES CITED

Harris, L. F., 1972, The role of climate in the morphology and evolution of Mancos Shale slopes on the Colorado Plateau: Dissertation, PhD, The Johns Hopkins University. Presented Nov. 1972 at Geol. Soc. America annual meeting, Minneapolis; Abs. published in Abstracts with Programs, v. 4, no. 7, 1972, p. 529.

Kodak Master Darkroom Dataguide, [3d ed.; (1st ed., 1970)]: Eastman Kodak Co., Rochester, N. Y.

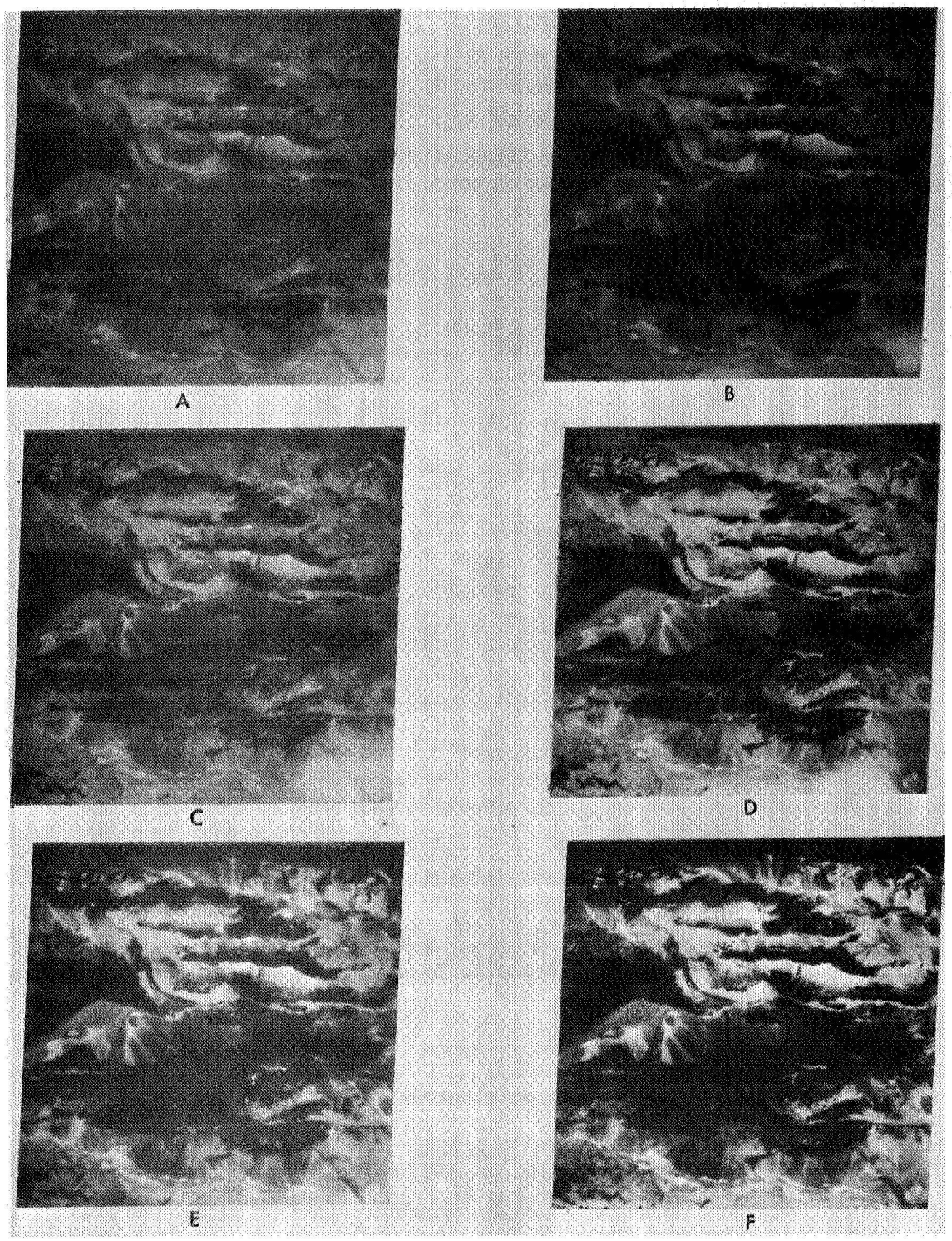

Figure 1. Illustration of the relative degree of contrast for each combination of developer and film-type used. Contrast increases from A to F. Note in particular the increase in contrast of the lakeside dunes in the left center. The photographs are of ERTS frame 1074-24242-7, the Takla Makan Desert in China. All negatives were printed on contrast grade 3 paper. A, Plus X Pan developed in Kodak D-76; B, Panatomic X developed in Kodak D-76; C, Plus X Pan developed in D-11; D, Panatomic X developed in D-11; E, High contrast copy 5069 developed in DK-50; F, High contrast copy 5069 developed in D-11.

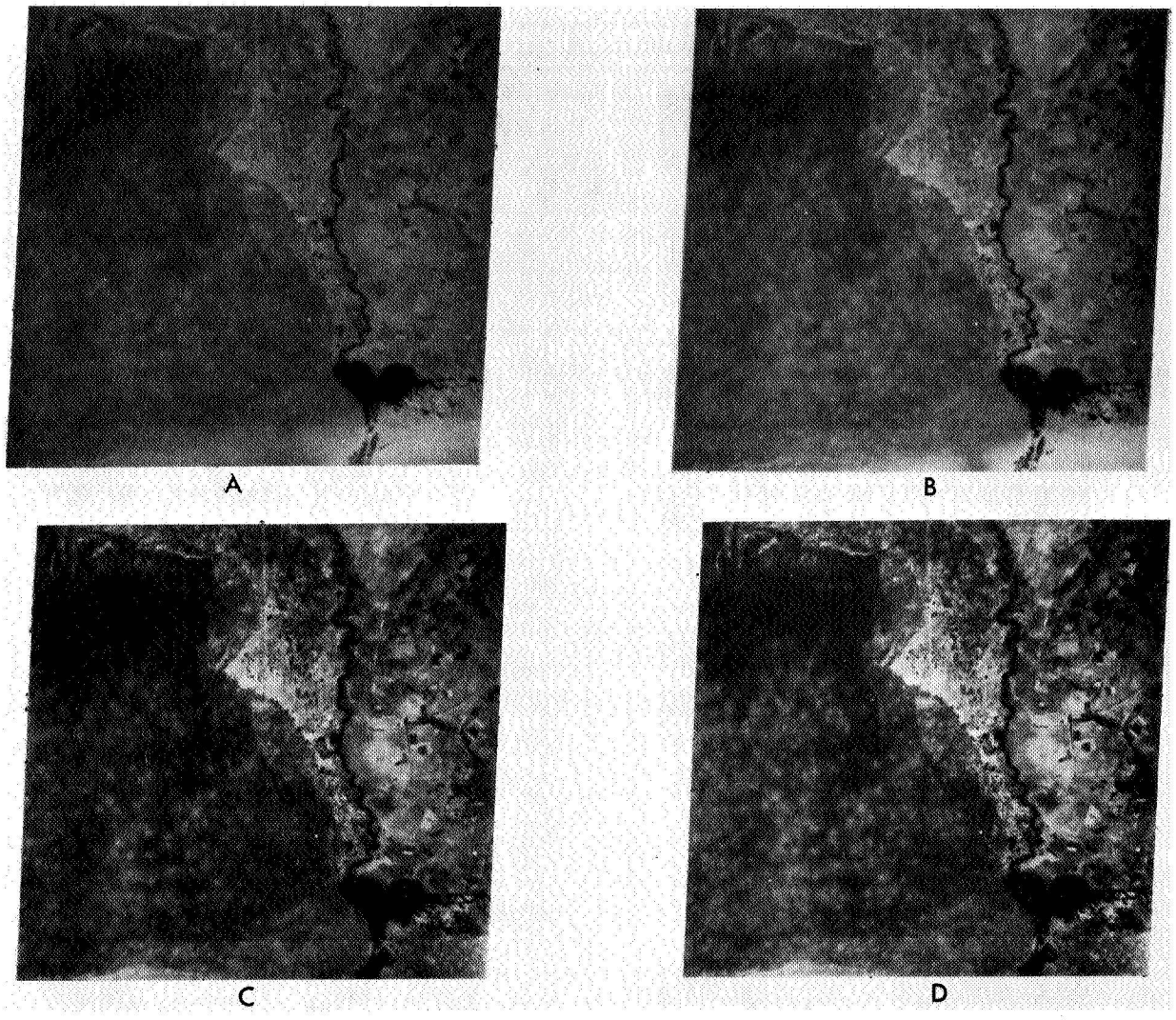

Figure 2. ERTS 1070-05443-7. Contrast enhancement of ERTS images using the three film types overdeveloped in Kodak D-11. See text for explanation.

A, Plus X
B, Pan X
C, High-contrast copy
D, High-contrast copy with polycontrast enhancement

Location: west of Tashkent, U.S.S.R.
Note the increase in contrast of the "patterned ground" and dunes in the lower left and center from A to D.

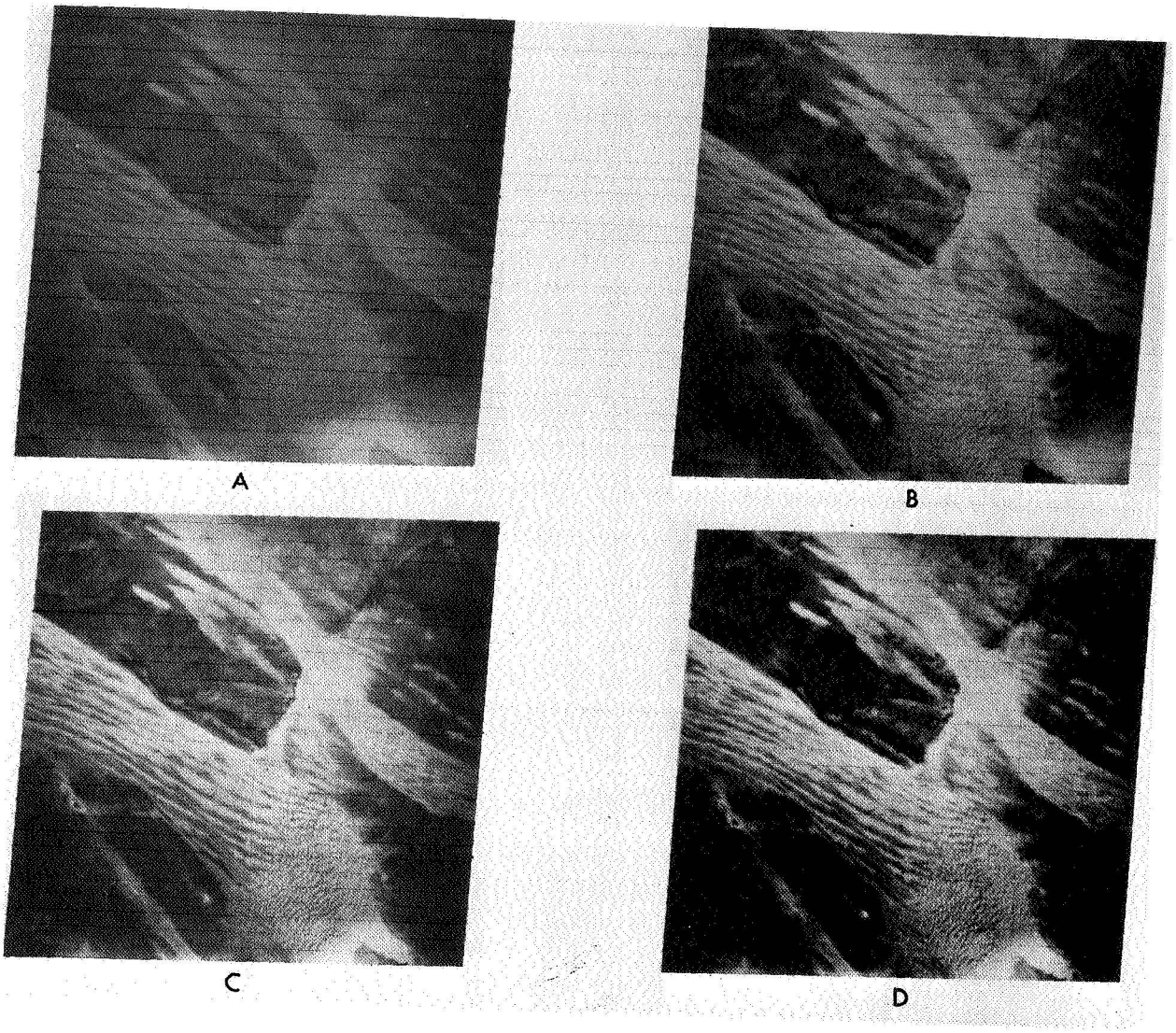

Figure 3. ERTS 1083-07033-7. Contrast enhancement of ERTS images using the three film types overdeveloped in Kodak D-11. See text for explanation.

A, Plus X
B, Pan X
C, High-contrast copy
D, High-contrast copy with polycontrast enhancement

Location: An Nafud Desert in Saudi Arabia.
Note the increase in contrast of both large and small eolian landforms.

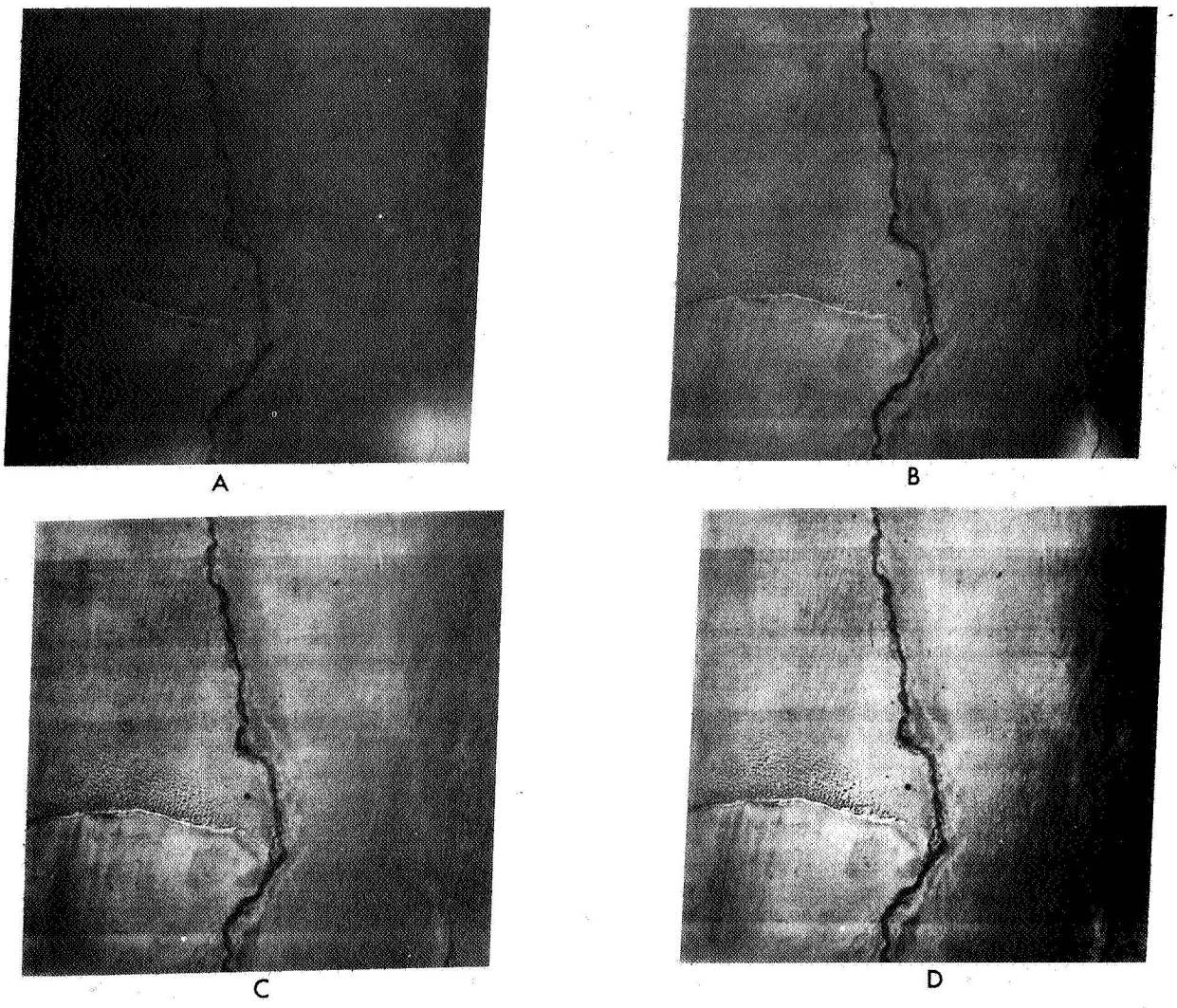

Figure 4. ERTS 1078-04481-6. Contrast enhancement of ERTS images using the three film types overdeveloped in Kodak D-11. See text for explanation.

A, Plus X
B, Pan X
C, High-contrast copy
D, High-contrast copy with polycontrast enhancement

Location: Takìa Makan Desert, China.
Note the increase in contrast of the small dunes in the lower left center.

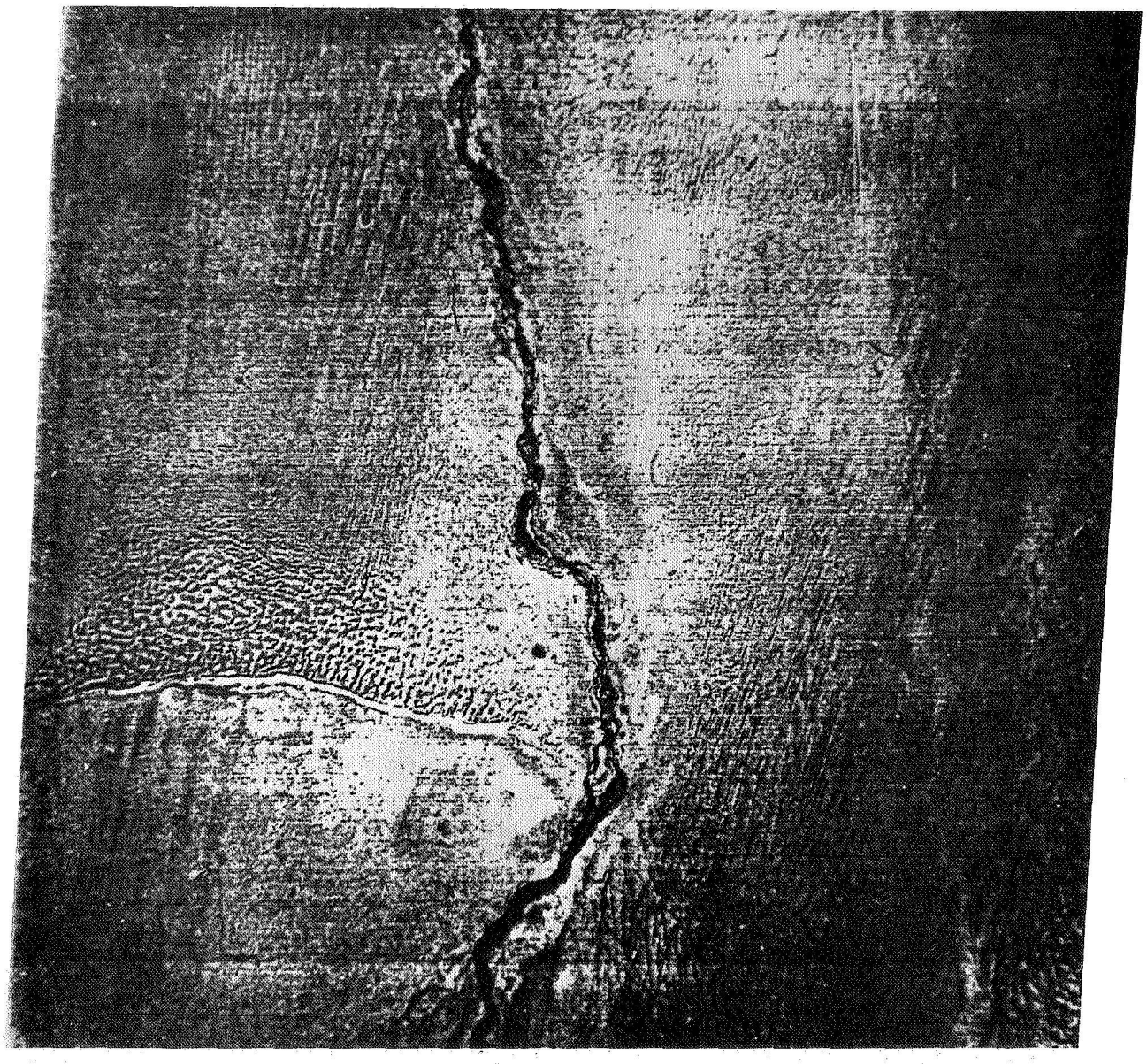

Figure 5. Contrast enhancement of ERTS 1078-04481-6 (shown in fig. 4), by photocopying on the IBM Copier II. The photocopy was made from an 8" X 10" photograph printed from a contrast-enhanced negative. This process further delineates topographic boundaries and aids in the measurement of morphologic parameters.