son, much of the plotting of terrestrial photography has been done is Europe. On the other hand, inexpensive instruments such as the Kelsh Plotter, which are used by almost all mapping organizations in this country, can be used for plotting a map from aerial photography.

In order to determine the suitability of the Kelsh Plotter for mapping of glaciers at the specified scale and contour interval, the author plotted maps of the Polychrome Glacier in both the Wild A-7 and the Kelsh Plotter. It was necessary to plot the maps at a scale of 1:6,000 in order to be within the range of the Kelsh Plotter. In each of the two models required for plotting there were eleven control points, five points being common to both models. For the Wild A-7 a standard elevation error of ±0.5 meters was obtained, and for the Kelsh Plotter a standard elevation error of ±0.9 meters was obtained. These values are entirely satisfactory. There was no significant difference in the plotting time of the two instruments. Although the Kelsh Plotter does not give nearly as large or well-defined an image as the Wild A-7, a comparison of the contours and planimetry of the two maps showed very good agreement. However, for the best results the author would recommend lowering the flying height from 15,000 feet to 12,000 feet, for plotting in the Kelsh Plotter.

## Conclusions

Many important and interesting applications have been found for terrestrial photogrammetry in recent years. The author feels, however, that, where economically feasible, aerial photogrammetry in most cases offers a more satisfactory solution to the problem of mapping glaciers.

# *A Geographic Approach to the Study of Photo Interpretation*

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ABSTRACT: *Since the air photo is a representation of the landscape, no photo can be interpreted without an understanding of what makes up the landscape. A curriculum in photo interpretation should include the following stages: the rudiments of morphology, geology and other earth sciences; after these have been assimilated, the basic principles of air photography; later, the more advanced principles of physical geography and the study of man-made features in the landscape; and only then photo interpretation. Interpreters trained by this method will be successful both in forestry and civil engineering and will be able to take up independent research in the earth sciences.*

If the scientific and technical world has not already learned to exploit all the potentialities of air photography, this is largely due to a shortage of experts of the required caliber in interpreting air photos.[1] Because of the long period required to amass adequate experience in interpretation, an insufficient number of students attain the required standard,[2] either in the United States or in smaller countries, where the problem is serious. Those who teach photogrammetry and photo interpretation must try to shorten this period, and at the same time must attempt to raise the standard.[3]

Let us not delude ourselves by thinking that photography is only a tool in obtaining information about some aspect of the landscape we photograph. The photo interpreter cannot do a top job of interpretation unless he has acquired a real grounding in one of the earth sciences and he has more than nodding acquaintance with the other sciences dealing with the element of landscape. Experience has shown that the students who had mastered a real understanding of these elements achieved a satisfactory level of

For Footnotes[1,2,3] see bottom of next page.


FIG. 1. Air photograph of study area showing: (a) first level—in chalky limestone; (b) second level—also in chalky limestone; (c) third level—in hard limestone; (d) alluvium; (A) depressions of uncertain origin, perhaps karst; (B) fault line; (C) karst sinkholes.

photo interpretation relatively sooner than students loaded down with mathematical photogrammetric knowledge but having no real geographical background.

No matter how thoroughly trained in quantitative methods and the most up-to-date processes, the X-ray technician cannot pick out the significant features of his photographs without a knowledge of human anatomy. Similarly the photo interpreter cannot fully assess an air photo without having been well schooled in the processes that determine the physical and man-made features of landscape.

Hence, the important role of the earth sciences in training a good photo interpreter. Once equipped with geographic knowledge, he will be able, without the aid of a map, not only to grasp the elements of the landscape on the photo but also to extrapolate from it and to make a good guess at the broader constructional landscape[4] of which the photographed area is a part.

What is the quickest and most effective way of imparting the required understanding? In view of the fact that it is more difficult to master interpretation than photogrammetry,[5] the question is a vital one. In our Department the instruction is in two distinct stages—one course at the undergraduate level and the other for graduates only.

In the undergraduate course, the student goes through the elements of air photographs, photo reading and photo analysis, learns to look at stereograms through binoculars, etc. Analysis is taught by a method that we have found effective and economical. A stereogram, a stereoscope and a desk lamp are at the side of each student. By means of a dia- or an episcope, the lecturer projects the stereogram of the study area on a screen. After he has pointed out each detail on the screen, the students switch on their desk lamps and locate this detail on their own stereograms. The lamps are then put out again and the lecturer proceeds to the next detail. No student is admitted to

[1] McLerran, I. H.: "Photographic Interpretation—Its Significance in the Highway Program," PHOTOGRAMMETRIC ENGINEERING, 23, No. 4, pp. 755–761, especially p. 756.

[2] Smith, H. T. U.: "Photo-Interpretation of Terrain" in *Selected Papers on Photogeology and Photointerpretation*, Committee on Geophysics and Geography, Research and Development Board, Washington 1953, pp. 7–29, esp. p. 29.

[3] Cheney, T. A.: "A New Interpretation of the Interpretation Situation," PHOTOGRAMMETRIC ENGINEERING, 23, No. 1, pp. 101–105.

[4] Lobeck, A. K.: *Military Maps and Air Photographs*, New York, 1955, p. 91.

[5] Heath, G. A.: "Correlations Between Man's Activity and His Environment Which May Be Analyzed by Photo-Interpretation," PHOTOGRAMMETRIC ENGINEERING, 23, No. 1, pp. 109–114.

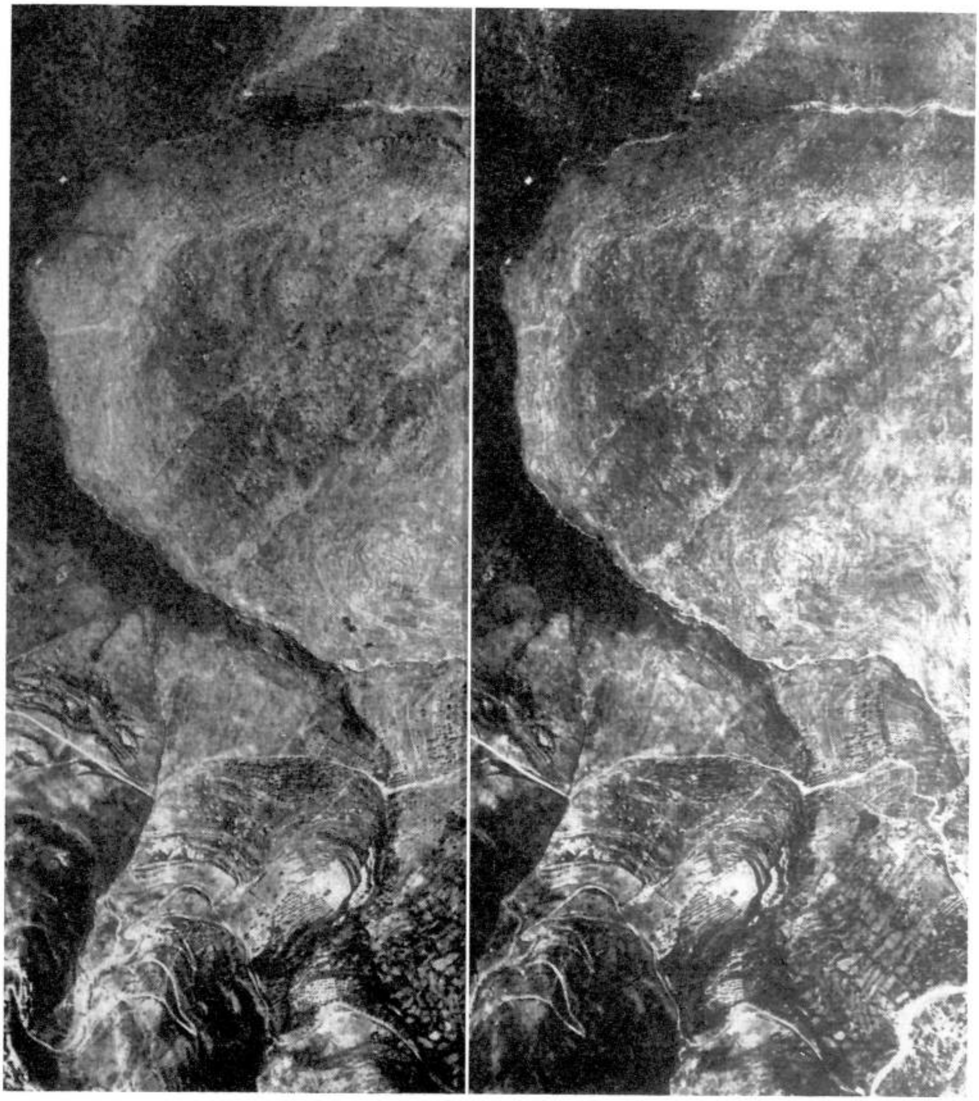

FIG. 2. Stereogram of a section of Figure 1.

the course until after he has acquired the basic principles of general geography, morphology, elementary geology, climatology, etc.

The course for graduate student begins with instruction in photo interpretation. Some time later he is trained in the use of air photographs in geographic research. No student is admitted to the course until he is about to conclude his course of studies for a master's degree in geography. By that time he is equipped with a broad knowledge in every field of geography, he has written papers and given seminar reports, and he is already working on his thesis, which generally requires independent field work. Our experience with the photo interpretation course has demonstrated that all this preparation pays off. As the weeks go by, the student emerges as a full-blown photo interpreter. On one fine day, as a result of slow maturing of the geographic knowledge within him, we find the interpretative ability is there.

In one of the first exercises in this second course, the students were asked to supply morphologic data about one study area. After seminar discussion, the following analysis was supplied by one student, Zvi Ron, who divided his presentation into seven parts:

1. a topographic outline of the photographed area, supplying also the names of the streams, mountains, places of settlement and ways appearing on it. See Figures 1 and 2;
2. an outline of the general morphological framework or constructional landscape, including the conclusion that the relief is moderate with the exception of deep valleys sectioning off the area, shown on the photographs, into large segments;
3. a lithographic map of the area, showing the various kinds of geological formations, of which he found three kinds—chalky limestone (Cenon), hard limestone (Cretaceous) and alluvium;
4. the hypsographic division of the area on the basis of the relative altitudes of the various levels and the differences in tone between them. This was accompanied by the conclusion that the hypsographic pattern was governed by the lithological differences;
5. tracing the local tectonic lines, which show up clearly on the photograph but are difficult to locate in the field in places;
6. an analysis of the hydrographic net, in which he discovered stream captures and a lack of correspondence between the drainage pattern and the local fault lines;
7. finally, the identification of characteristic features of karst topography in the hydrographic net, and the observation that these features are confined to certain parts of the photograph area, occurring in the hard limestone but not in the chalky limestone area. Study of the photographs readily reveals the difference in the density of the hydrographic net between the two zones, with the sharp erosion baselevel exerting no influence on the drainage patterns in the hard limestone; a number of karst sinkholes also show up fairly clearly.

One of the requirements that the study method described herein does not meet is the quantitative one. However, where research involves photo-geography and photo interpretation only, the method assures satisfactory results.

In *conclusion* the author suggests that the quickest way to teaching photo interpretation is a thorough grounding in the elements of physical geography and photo-geography. The interpretative ability will be evolved in a natural maturing process.

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