*A Photogrammetric Profile Plotter for Geologic Use**

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ABSTRACT: *This paper describes a photogrammetric instrument for plotting profiles directly from multiplex-type stereoplotting equipment, with accuracy at least equivalent to profiles taken from a stereo-compiled topographic map. The ease with which profiles, that are satisfactory for many phases of geologic work, can be drawn by photogrammetric means should lead to wider use of profiles in geologic mapping.*

INTRODUCTION

ONE form of geologic representation requires the construction of ground profiles. When the geologic boundaries of rocks have been plotted on the profile and their inclination has been determined, one has constructed a geologic profile, a widely-used form of geologic representation. A normal geologic map is incomplete unless it includes vertical profile sections which show the distribution and larger features of rocks and soils along the line of section; the inclination of stratified rocks; and the form, trend, and relationship of folds. When topographic maps are available, the plotting of profiles depends on graphic construction made by point-by-point transfer of spot heights and contour-line elevations. For this reason the profile taken from the topographic map may omit certain details that are located between the contours. When topographic maps are not available, profiles can be run on the ground by planetable traverse, or levels, but this work also results in point-by-point graphic plotting of spot heights. In areas of great relief, profiles run on the ground are costly. In remote or inaccessible regions they become impractical.

A PHOTOGRAMMETRIC PROFILE PLOTTER

A photogrammetric profile plotter has been built under the auspices of the Geological Survey's Interdivision Committee on Photogrammetric Techniques in Geology, in recognition of the need for a photogrammetric profiling method. The profile plotter consists of a multiplex-type tracing table on which a plotting pencil is mounted in the plane of the platen, as shown in Figure 1; the pencil plots the profile directly upon a sheet of graph paper mounted in a vertical plane upon a board (Figure 2).

OPERATION

There are essentially two approaches to photogrammetric profile plotting: (1) When there is adequate horizontal and vertical control for the single stereoscopic model; and (2) When control is not available for each model but the models can be leveled by bridging.

In the first case, that of *adequate control*, the stereoscopic model is first scaled to horizontal control, then leveled to vertical control. The horizontal position of the ends of the profile line are plotted on the manuscript, and a line drawn between them. The operator then places the plotting board (Figure 2), parallel to the profile line; then a sheet of graph paper having the appropriate scale, is adjusted to the given elevations at the ends of the profile. The tracing table is moved along in the direction of the profile line, guided by a slotted track which is joined to the board. The rise-and-fall of the floating mark as kept in contact with the ground in the stereoscopic model is directly transmitted to the plotting pencil which traces the profile upon the plotting board. The speed of plotting is governed by the complexity and degree of relief and the ability of the operator. He can stop and go at will; check his plotting; obtain spot elevations; or plot the vertical position of geologic contacts, faults, outcrops, and other features as they are encountered along the profile.

* Publication authorized by Director, U. S. Geological Survey.

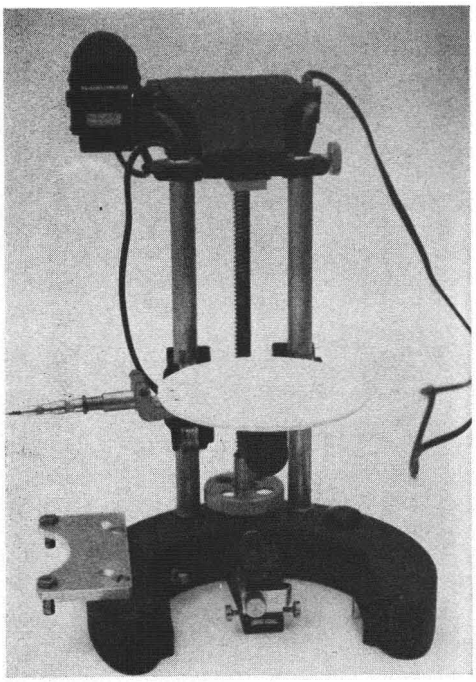

FIG. 1. Plotting table and stylus.

In the second case, that in which *bridging is necessary* to extend horizontal and vertical control, elevations are determined at enough critical points on the stereoscopic models so that they may be correctly leveled. Normally, this means a minimum of four points, one in each corner of the model. Horizontal bridging, or stereotriangulation, is employed for the horizontal scale solution using the methods of reciprocal and exterior orientation. Similarly, in vertical bridging these methods are employed to develop a *BZ* curve, or curves, from which corrections are obtained to correct for vertical bow, and twists or slopes in the *y*-direction. Further details on this method are given in the "MANUAL OF PHOTOGRAMMETRY," or in any similar standard text on stereotriangulation.

Figure 3 illustrates bridging with the multiplex over five continuous models which have been oriented by bridging for the purpose of obtaining corrected elevations for each individual model. Subsequently, each model is re-oriented to its own vertical and horizontal control, ready for the profile-plotting phase.

In its present state the profile plotter can be used with the multiplex or ER-55 instruments only. The Kelsh plotter cannot be employed because the guide rods would interfere with its operation; however only minor modifications are needed for practicable operation.

EXAMPLE OF PROFILE PLOTTING

A problem was submitted covering an area in Wyoming; aerial photographs showed where a proffle, about 6 miles long, was required. The area selected was in rough topography having considerable relief, and precluded making an economical planetable survey on the ground. Ade-

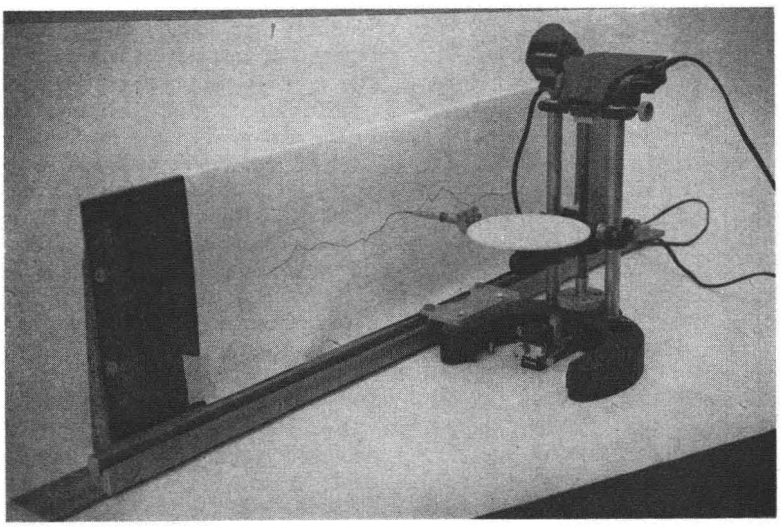

FIG. 2. Photogrammetric profile plotter.

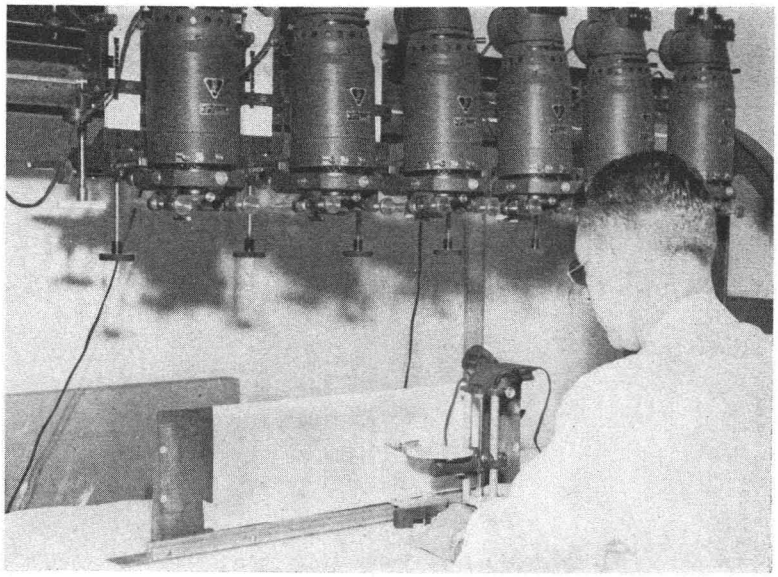

FIG. 3. Plotting a profile from bridged control.

quate topographic maps were not available from which profiles could be drawn by the usual graphic methods. Some interesting problems in bridging were presented since a recent topographic map, made available good control only at one end. The remaining controls were points from an old non-standard 1:125,000 topographic map, which carried only 100-foot contours. The multiplex models were bridged using the good control at one end and tying-out to the average control at the other end. Office work on this project has been completed and the profile has been sent to the field for testing. A preliminary appraisal of the line indicates that the cost of the photogrammetric profile plotting is less than a similar profile plotted by plane-table or other field method.

ADVANTAGES OF PROFILE PLOTTING

Photogrammetric profile plotting has the advantage of reaching easily into areas where access is difficult because of the nature of the terrain or impossible because access to the area may be denied. Profiles can be plotted under a stereoscopic plotter with about the same ease as in contour plotting; but, since the profile is plotted continuously, more detail may sometimes be obtained as compared with graphic constructions using contour maps, where it is necessary to plot the profile from contour to contour. Furthermore, it should be noted that stereo models are usually three or more times larger in scale than the published maps resulting therefrom. Also, where a large contour interval is used on a map, minor slope changes of possible geologic significance would not be shown by the contours, but they could be shown on a continuous profile plotted from the stereo model.

Profiles can be drawn anywhere under a stereoscopic model. The location of a geologic section, however, depends on the features that the operator wishes to show; profiles, therefore, are usually drawn perpendicular to the strike of the stratified rocks to show the dip of the rocks.

Another advantage of photogrammetric profile plotting is that all the elevations along the profile can be referred to sea-level and read directly. Horizontal distances between points on the profile can be measured directly. The accuracy of the profile plot may be made consistent with the accuracy of any map that can be compiled from the same data. Photogrammetric profiles show slopes in a detailed, clearly defined manner as the photogrammetric profile becomes a continuous projection of the terrain surface upon a vertical plane. It should be remembered, however, that the accuracy of the profile is dependent on the amount and accuracy of control obtained in the field or available

from other sources. Also it should be borne in mind that profiles, like contours, can be best drawn when there is no interference from vegetative cover; when forest cover prevails, an accurate profile would be difficult if not impossible to determine.

As the geologist becomes better acquainted with photogrammetric instruments, and they are made more available, profile plotting with instruments of this type will increase. The ease and reliability of photogrammetric profile plotting should lead to more use of profiles than has been heretofore possible.

*Medium-Scale Charting—A Challenge to Photogrammetry**

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ABSTRACT: *This paper explains some of the complexities encountered by the Aeronautical Chart and Information Center in compiling medium-scale charts by photogrammetric methods. Areas are charted in various parts of the world using a large variety of source material, many types of photography, and available but limited amounts of geodetic control. This requires the use of numerous procedures and techniques to accomplish chart production. Greater emphasis is planned on rapid photo revision techniques. Examples of materials available and methods of meeting the challenge are presented.*

MEDIUM-SCALE charting by definition is charting accomplished for publication at scales ranging from smaller than 1:100,000 and including 1:500,000. This definition is considered logical in view of a large number of aeronautical publications being printed at scales of 1:1,000,000; 1:2,000,000; 1:3,000,000 and 1:5,000,000. Examples presented in this paper were taken from charts prepared for publication at 1:250,000 scale.

JAMES W. HART, JR.

The principal elements of medium-scale charting which constitute the challenge to photogrammetry are as follows:

1. As a multi-purpose chart produced by the Air Force the 1:250,000 scale chart is the leader. This Aeronautical Approach Chart is a basic chart for strategic and tactical air operations (including air-ground support, interdiction, target run navigation and bombing). It satisfies to a large extent the large-scale planning and intelligence requirements as well. Because of its many uses and the development of the new weapons systems which have been described in the newspapers, this chart must conform to the most practicable accurate standards. Accuracy is the first element of the challenge.

2. Large areas in many parts of the world must be charted. The resulting

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