through airphoto interpretation, the latter is called "airphoto landscape." Field and library research may be applied to the "airphoto landscape" to resolve any differences between it and the actual landscape.

The Ingrid Christensen Coast of Antarctica, was selected as a demonstration area of limited accessibility. Preliminary airphoto analysis permitted the division of this cast into eight morphological areas which are described and analyzed from their airphoto images. In proving the value of utilizing photogeographical methods in areas of limited accessibility, the study has provided: (1) the first precise description of the major physiographic features of the area, (2) revised maps of this coastline, showing newly discovered fiords, inlets, islands, peninsulas, ice tongues and inland features, (3) observable evidence relative to a probable uplift resulting from glacial unloading, (4) observable evidence of the metamorphic character of the bed rock along this coast which was formerly described as sedimentary and igneous, (5) the delineation and analysis of the ephemeral Sandefjord Ice Bay, (6) the delineation, analysis and rate of movement of the dynamic Publication Glacier Tongues, formerly thought to be shelf ice and (7) the discovery, delineation and first mapping of the Baker Three coastal area. In addition, numerous problems were isolated which merit future study.

Unusual items among the illustrative and appended materials include an Antarctic surface trafficability chart; nomographs for the duration of sunlight and civil twilight in the Antarctic; original maps, revised maps and annotated airphotos of the Ingrid Christensen Coast; a map of the airphoto coverage of Antarctica; a bibliography of photo interpretation bibliographies and a bibliography of Antarctic bibliographies.

THE USE OF AIR PHOTOS FOR TERRAIN INTERPRETATIONS AT LONG RANGE*

M. M. Elias, U. S. Geological Survey

TERRAIN analysts of the U. S. Geological Survey use air photos in conjunction with field work and as a valuable source of information in making office studies of remote areas when field investigations are impracticable.

Air photos are more usable for detailed interpretations involving small areas, such as individual airfield sites, than they are for small-scale studies covering large areas. The large number of photos required to cover an entire country, for example, makes their use too cumbersome, and they are generally not necessary except where there are few if any other sources of information.

Although indispensable for studies of little-known areas, air photos also have value in well-known areas. For the latter, air photos serve as an additional source of information and have a unique value in delimiting and refining boundaries of known terrain elements, and in providing details beyond those available from published topographic, geologic, soils, and vegetation maps. Within limits, air photos can thus substitute for additional ground surveys.

A representative example of interpretation in well-known areas is presented by a study made by the U. S. Geological Survey, estimating the airstrip construction problems in a selected area at Fort Bragg, North Carolina. The esti-

* Paper read at Nineteenth Annual Meeting of the Society, Hotel Shoreham, Washington, D. C., January 16, 1953. Publication authorized by the Director, U. S. Geological Survey.

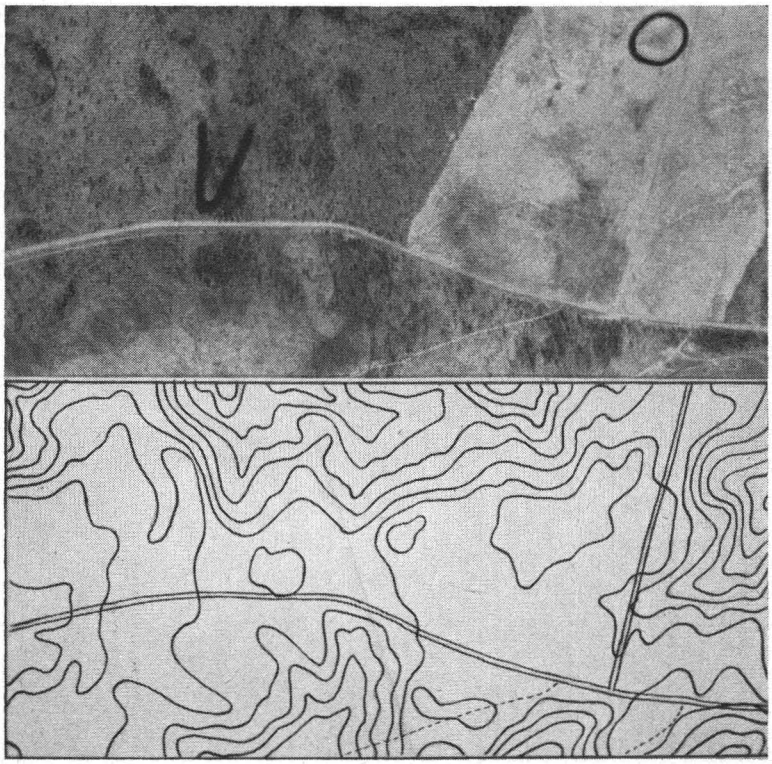

FIG. 1. Air photo and 1:10,000-scale topographic map with 10-foot contours. The air photo of the same area shows additional relief features: on the left is marked a ravine, in the upper right a wet depression.

mate was prepared in Washington, D. C., using only published material, air photos, and the experience and knowledge of available scientific personnel. Agricultural Adjustment Administration air photos at a scale of 1:20,000 were used. They provided complete stereoscopic coverage.

Other sources of information were: 1) a U. S. Department of Agriculture county soil survey report of 1921 with a map at a scale of 1:63,360; 2) an Army Map Service topographic map at a scale of 1:25,000 with 10-foot contours; 3) general geologic descriptions of bedrock formations and a very generalized State geologic map at a scale of 1:1,000,000; and 4) a few ground photographs made by the Signal Corps, U. S. Army, showing vegetation and drainage.

Personnel involved were A. Clebsch, Jr., and C. R. Warren, geologists of the U. S. Geological Survey, and M. E. Austin, pedologist of the Soil Conservation Service. They consulted with other scientists who had field experience in areas similar to the site area, but none of the men had been in the Fort Bragg reservation.

In preparing a detailed estimate of terrain and engineering conditions anticipated at the site, all available sources were used. The contribution of air photos was notable in the following ways:

In estimating *grading* and *drainage* factors the air photos showed ravines, drainage lines, and low wet spots beyond those shown on the contour map. A sample detail from the topographic map (see Figure 1) covers a divide area that seems to have a continuous gentle surface suitable for runways. The air photo indicates a ravine and a wet depression within the divide area, which

would require more filling than would be estimated from the topographic map alone.

In estimating *foundation* conditions the air photos made possible the refining of known soil boundaries. An example of the details that were added to the basic soils map is shown in Figure 2. The soils derived from the variable bedrock in the area are complex, with minor inclusions of other soils within the mapped units. Pedologic terms given on the source map were translated into engineering terms for the study.

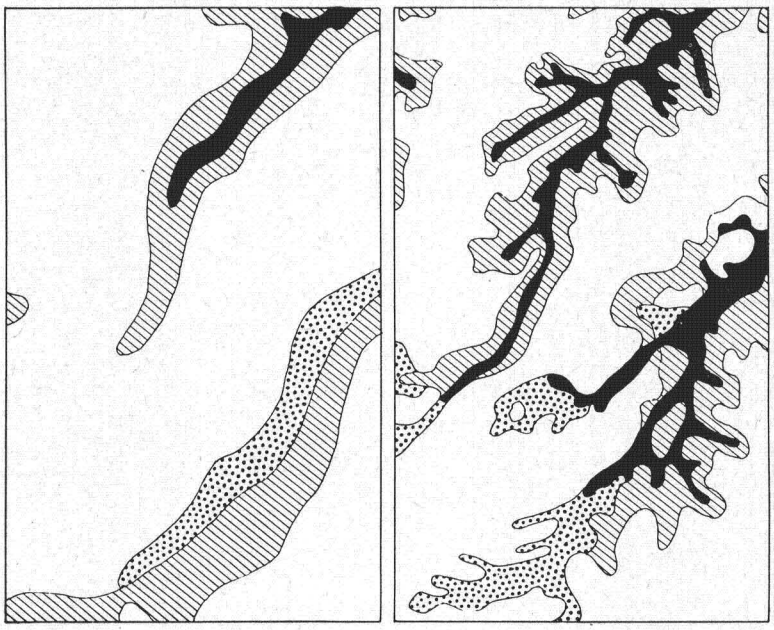

FIG. 2. A. Part of a 1:63,360-scale soil survey map, slightly enlarged. B. The same area with details added from air photos. On both maps deep sand on divides is shown blank, clayey sand on slopes is shown by diagonal lines where shallow and by dots where moderately deep, and organic silt on swampy bottoms is shown black.

For estimating *clearing* problems the air photos provided tree sizes and densities. Pines and oaks were identified and counted on the air photos, their heights were estimated by measuring shadows, and their diameters were roughly inferred by relating height, crown density, and crown diameter to trunk diameter, as provided in U. S. Forest Service tables.

Determination of *access* was aided by spotting trails and jeep tracks on air photos, which indicated routes additional to those marked on the topographic map.

The results of the study were field-checked during a military exercise, at which time an airstrip was constructed. Estimates and interpretations were found to be essentially correct. The field check confirmed the selection of one site in the area as the best topographic location. The selected site required a minimum of grading and had no drainage problems. The foundation consisted of poorly graded sand requiring the addition of binder material as anticipated; however, the thickness of the sand was less than predicted; instead of 10 feet, in a few places it was as thin as 1 or 2 feet. The estimate of tree sizes was correct in general. A few trees were larger than the average estimated; although most

trees were less than 14 inches in diameter and could be bulldozed; less than a dozen in the cleared area were 18 to 20 inches and had to be blasted. The anticipated access routes were usable with minor improvements.

For the study, suggested sites for borrow pits and quarries had been picked almost entirely from published reports and maps. The field check indicated that a more detailed soils map could have been made 1) if good quality photos on a larger scale, preferably at least 1:10,000, had been available, and 2) if some spot ground check had been possible or if the interpreters had had previous field experience in the regional geology. The detailed soils map would doubtless have shown more suitable sites for construction materials.

PHOTO INTERPRETATION IN FORESTRY*

Kendall B. Wood, Consulting Forest Engineers, 436 Terminal Sales Bldg., Portland 5, Oregon

SEVEN years ago, when I organized my private practice as a logging engineer and timber consultant in Portland, photogrammetry and aerial photographic interpretation as applied to timber problems was considered by practically all Northwest timber people to be only an interesting experiment. It is true that the aerial photographs had been used for some years in parts of the East and particularly in Eastern Canada. Stuart Moyer has provided information on some of the work the Fairchild Company had done in the early twenties in the pulp timber areas of Eastern Canada. Stephen Spurr had laid the foundation for scientific use of photogrammetry in timber appraisal work and had developed the techniques of using modified infra-red photography for distinguishing conifers from hardwoods. The Forest Experiment stations were using available photographs as an aid in preparation of Forest Survey type maps of the country. Nevertheless, in the West, where the bulk of the reserve timber in the country stands, very few, if any practical timber people expressed much interest in the use of aerial photography for map preparation or timber cruising work.

The change in seven years has been remarkable. In this time the timbered areas of the West experienced the greatest economic boom in their history. Stumpage rates have climbed greatly in excess of normal inflation and a pressing need has developed to get quick surveys of large undeveloped areas and to reassess areas hitherto surveyed and rejected because of low grade timber or inaccessibility.

Tremendous areas had to be covered rapidly in order to beat competitive buyers on a prospective timber buy. The forestry profession accepted this challenge and started applying photo-interpretation and photogrammetric map-making methods to meet the time requirement. Mistakes were made and are being made because of over-enthusiastic use of aerial photographs by foresters lacking in photogrammetric training, but on the whole a good job is being done.

The Society owes a debt of gratitude to the Forestry profession for "selling" photogrammetry to the timber industries, for today there are very few if any large timber owners in the West who do not utilize aerial photography in some phases of their work. There are already several large firms which employ staff photogrammetrists in addition to their forestry personnel. Practically all Forest schools now conduct courses in photogrammetry. We employ a number of young foresters during the summer and have been amazed to find that most of them

* Paper read at Nineteenth Annual Meeting of the Society, Hotel Shoreham, Washington, D. C., January 14 to 16, 1953. It was a part of the Report of the Photo Interpretation Committee.