The interpretation presented explains the relationships between the three formations in a logical manner, and appears to be the only one that can satisfactorily reconcile all the geological observations.

The structure of the area is controlled by normal faulting. Folds can be recognized within formation 3, but they are of a minor importance and may be related to small faults where the reversals are abrupt.

Reference was made to a 1:1,000,000 geological map of British Somaliland and its accompanying report* in order to establish the age of the formations recognized on the photograph. Although the scale of the map is too small to allow any direct comparison of the structure, it appears probable that the succession is as follows:

Formation 3—Anhydrite Series.
Eocene
(Banded anhydrite interbedded with limestone layers)
Formation 2—Arnado Limestone.
(Hard, massive and thick bedded limestone.)
Formation 1—Nubian Sandstone.
Cretaceous
(Sands and quartzites.)

An additional series, the Allahkajid beds (limestones and shales), occurs between the anhydrite and the Arnado limestone. From an examination of the photographs it appears probable that this series occurs near the base of the scarps that bound Formation 3.

Grateful acknowledgement is made to the Directorate of Colonial Geological Surveys for the loan of the relevant photographs from their collection; to the Air Ministry for supplying copies of these and granting permission to publish them; and to the Directors of Seismograph Service (England) Ltd., for permission to publish this paper.

REPORT OF UNCLASSIFIED MILITARY TERRAIN STUDIES SECTION†

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A SUBJECT heading such as this is almost meaningless for the various military agencies. With few if any exceptions all terrain studies carry a security information classification of some kind.

The members of this section have investigated their respective agencies and to the best of their knowledge there are no unclassified military terrain studies. In a few instances they do have however some associated projects which may be of interest. These can of course be mentioned only briefly in this section report. Each paper will be published in full at a later date.

Captain Ethan Churchill of the Reconnaissance Branch, Directorate of Intelligence, U.S.A.F. has prepared two manuscripts for later publication. One, titled "Principles of Plant Ecological Aerial Photographic Interpretation," will probably be published in the official journal of the Ecological Society of America. The other paper with a tentative title of "Principles of Vegetation Type Aerial Photographic Interpretation" is expected to be published at a later date,

* "The Geology of British Somaliland." W. A. Macfadyen. Gov. of Somaliland Protect. 1933.

† 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.

perhaps in the PHOTOGRAMMETRIC ENGINEERING. Both papers deal with the vegetation phase of terrain analysis which often is a diagnostic feature in any terrain study. In many places vegetation rather thoroughly blankets the terrain, masking many diagnostic landform features which might otherwise give clues as to the underlying terrain. Consequently a full understanding of the part played by vegetation in any terrain study cannot be under-estimated. Many interesting and important papers have been prepared on the recognition of vegetation and their use as indications of the underlying terrain. These two papers will add considerably to the important field of photographic intelligence.

Mr. Robert Sager, also of the Reconnaissance Branch of the Directorate of Intelligence U.S.A.F., has assembled two papers. One deals with a collection of aerial photographs showing classical examples of various landform types and titled "Index to Aerial and Ground Photographs Illustrating Geologic and Topographic Features Throughout the World." This collection is for the most part available to the general public. The second paper is devoted to a report prepared by Dr. John Roscoe on the terrain and ice conditions of the Antarctic and titled "Contributions to the Study of Antarctic Surface Features by Photogeographical Methods." Both papers are unclassified and deal with the highly important landform aspects of any terrain study. Like vegetation, a study of terrain conditions must of necessity include a thorough understanding of the landforms and drainage patterns. These together with the vegetation pattern present a reliable basis for conclusions concerning the military aspects of terrain conditions. Mr. Sager's reports will add considerably to the growing knowledge of interpreting terrain conditions from aerial photography.

Messr's Benninghoff and Elias of the Military Geologic Branch of the U. S. Geological Survey have been doing important work for the Army Engineers, Each has prepared a short paper. Their papers which will be of considerable interest are titled, "Use of Airphotos for Terrain Interpretation at Long-Range" by M. M. Elias; and "Use of Airphotos for Terrain Interpretation Based on Field Mapping," by W. F. Benninghoff. Both writers have had considerable experience in this field and have contributed considerably to the advancement of photographic interpretation.

Mr. Witenstein of the Engineering Strategic Intelligence Division, Army Map Service has evolved a technique for using vegetational indicators as an aid in interpreting terrain conditions, and has prepared a paper tentatively titled "Elements of Regional Keys on the Interpretation of Vegetation."* He has contributed considerably to the advancement of photo interpretation and has presented several papers on this subject.

At the Naval Photographic Interpretation Center, all Military Terrain Studies carry a security classification. A few associated and unclassified projects may be of interest. Such a study was initiated through a request by the Committee on Plant and Crop Ecology, National Research Council and with the full cooperation of the National Bureau of Standards and the Division of Cereal Crops and Diseases of the Department of Agriculture. It was felt desirable to develop a method for distinguishing between diseased and healthy cereal crops by means of aerial photography. Consequently aerial and ground photographic coverages was obtained at two test areas, one at Stillwater, Oklahoma and the other at Langdon, North Dakota.

Samples of wheat having high and low rust severity (based on the percentage of the total leaf area occupied by visible spore masses) were obtained from the fields at Stillwater, Oklahoma. From these samples, the light reflec-

* This paper is not in this issue.—*Editor.*

tivity of the leaves having high and low rust severity was obtained by the U. S. Bureau of Standards through spectrophotometric analysis. The per cent of reflectance was plotted against wave lengths ranging from 400 to 1,100 millimicrons. Reflectance curves obtained by the Bureau of Standards for the wheat leaves (Figure 1) showed that the leaves having a high rust severity gave a higher percentage of reflectance in the visible spectrum—approximately between 390 and 760 millimicrons—than those having low rust severity. However in the higher wave lengths, or above approximately 730 millimicrons, the reverse was true. This means, barring other factors, that wheat leaves with a low rust severity, when photographed in the visible spectrum, should appear darker in tone than wheat with a high rust severity. The reverse would be true in the infrared range above 760 millicrons. Thus by a judicious use of photographic films and filters, it should be possible to separate the areas of wheat having a low rust severity from those having a high rust severity.

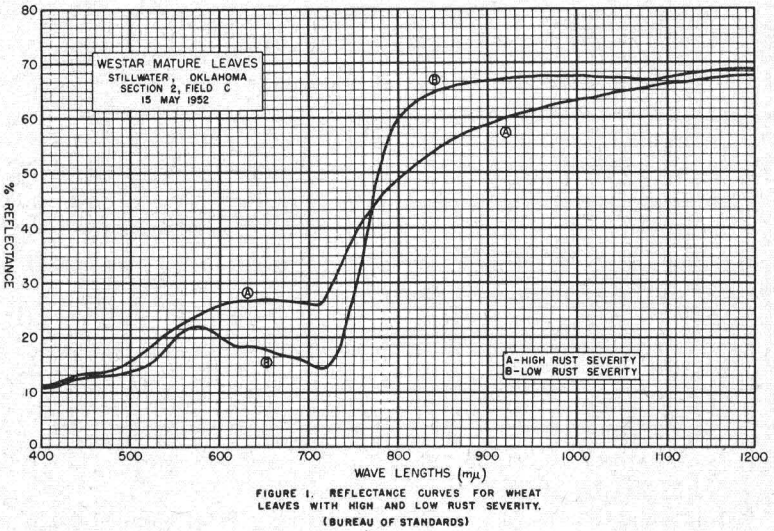

FIGURE 1. REFLECTANCE CURVES FOR WHEAT LEAVES WITH HIGH AND LOW RUST SEVERITY. (BUREAU OF STANDARDS)

FIG. 1. Reflectance curves for wheat leaves with high and low rust severity.

The film filter combinations used were panchromatic film with the Wratten 12 (medium yellow) filter which will pass all wave lengths above approximately 500 millimicrons; panchromatic film with the Wratten 25A (light red) which will pass only wave lengths of 600 millimicrons or longer; and infrared film with the Wratten 89A (dark red) filter which will pass only those wave lengths longer than 700 millimicrons. In addition Ektrachrome transparencies were obtained at both test sites. As the greatest difference in reflectancy between the healthy and the diseased wheat leaves occurs above 600 millimicrons, the latter two film-filter combinations should show this difference most clearly. Of the two combinations, the infrared film with the Wratten 89A filter gave the best results, but only then with the photography taken at Langdon, North Dakota. Here the diseased wheat appeared dark in tone in contrast to the lighter toned healthy wheat (Figure 2). This contrast between the diseased and healthy wheat was not so apparent in any of the other film-filter combinations taken at either test location but should have been apparent on the infrared film with the Wratten 89A filter at the Stillwater, Oklahoma test area. No apparent reason for this lack of contrast on the infrared film of the Stillwater test area can now be given but it is hoped that better results can be obtained during a subsequent test. It

should also be possible to separate diseased and healthy cereal crops by means of photography taken in the visible range, by using panchromatic film and a sharp cutting filter such as the Wratten 25A or 29. As panchromatic film is sensitive only to light rays below approximately 700 millimicrons, the use of a filter which would allow only light rays of 600 millimicrons or slightly longer to pass should permit the identification of diseased and healthy cereal crops in this visible portion of the spectrum.

In addition to the separation by means of the infrared film and 89A filter, a noticeable contrast between the diseased and healthy cereal crops was obtained in the Langdon test area by means of the Ektachrome transparencies. On the colored transparencies the diseased cereal has a rather distinctive reddish-brown tone, while the healthy wheat has a tan or dark brown tone.

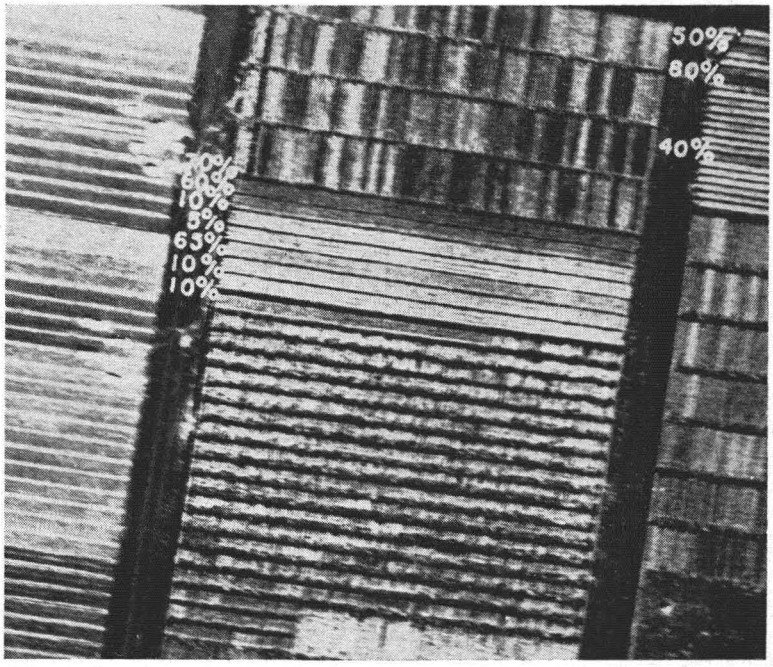

FIG. 2. Infrared photograph, Langdon, North Dakota, showing percentage of rust incidence.

From the limited tests made to date the best results were obtained at the Langdon, North Dakota test site and by means of infrared film using the Wratten 89A filter and by the Ektachrome transparencies. The better results obtained at the Langdon test site may be due in part to the fact that at Langdon the pathogen was a stem rust while at Stillwater it was a leaf rust. Also the test site at Langdon consisted of small, well controlled plots with five rows of grain per plot. Each plot contained a particular hybrid, with a tendency to uniform rust-susceptibility; however the rust-susceptibility of one plot usually differed from that of adjacent plots. In addition the plots were small enough to permit better sampling of the grain. The rust incidence ranged from about 5 per cent in some plots to 80 per cent in others. The plots of high rust incidence showed up very clearly on infrared and color photography.

At Stillwater the test area covered a strip about $\frac{1}{2}$ section wide and 20 sections long. The plots of wheat were large, irregular fields, intermingled with fields of other grain, pasture, and alfalfa. In many instances, fields of contrasting wheat types and degrees of disease incidence were so separated by other fields

that they could not easily be covered on one print as is necessary for direct tonal comparison. In addition the fields were so large that detailed sampling of the rust incidence was not possible and hence could not be verified from aerial photography.

It is expected that additional photographic tests will be conducted in the near future and from which supplementary data will be obtained.

INDEX TO AERIAL AND GROUND PHOTOGRAPHIC ILLUSTRATIONS OF GEOLOGICAL AND TOPOGRAPHIC FEATURES THROUGHOUT THE WORLD*

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THE Photographic Records and Services Division of the Air Force has a collection of photos illustrating miscellaneous geologic and topographic features of many areas throughout the world. All photos are unclassified and available to the public with the understanding that they will not be used in advertising which implies that the Department of Defense indorses or prefers any commercial product.

These photographs have been selected as type—"text book"—examples and examples depicting the land forms as commonly found. The illustrations in the collection are represented by single vertical or oblique photos or by vertical stereo pairs or triplets.

A mimeographed index to this collection was compiled in September 1946 and a supplement added in May 1949. A total of 603 illustrations are included in this index.

It is anticipated that a second supplement will be issued early in 1953. This will include some stereograms.

The photos are listed in the index by country in alphabetical order, and each photo is assigned an "Item No.," "Subject," "Location," "Number of Photos Available," "Type of Photo," and "Negative Numbers." The "Item Numbers" are consecutive and represent particular landforms. Supplements utilize this number plus a letter. The "Subject" includes some descriptive breakdown, i.e., moraines being listed as medial, lateral, or terminal. The "Location" is indicated by geographic coordinates to the nearest minute. The "Number of Photos Available" indicates the number of different representations available under that particular item number. "Type of Photo" refers to vertical, oblique, or ground photos and whether or not they are overlapping or in stereo. "Negative Numbers" refer to the file number system as used by the Air Force.

Since aerial photographs are not stocked but are custom processed for each order, they will not be loaned, sent on approval, or exchanged. The photographs will be supplied in not more than three copies of each exposure, only in the exact size of the available negative (no enlargement) on single weight glossy or double weight dull finish prints. Following is the current price per print: For quantities of 1–100, 55 cents each; for quantities of 101–1,000, 45 cents each; and for any number over 1,000, 40 cents each. The negative sizes are $7'' \times 9''$ or $9'' \times 9''$.

Since official Department of Defense and U. S. Federal Government activities must be given precedence, some delay in filling orders may be anticipated.

* 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.