GEOLOGICAL OBSERVATIONS ON AIR PHOTOGRAPHS OF THE PEACE RIVER AREA, BRITISH COLUMBIA*

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Introduction

THE area described is in latitude 56° N, 122°–123° N. It is chosen for study since it is typical of the foothills belt of the Rocky Mountains, and has already received some attention from geologists in the field.

Recently, a symposium of the American Association of Petroleum Geologists dealt with future oil provinces of the United States and Canada.[1] The largest of the little explored provinces dealt with there is a great mass of sediments lying between the Canadian Shield, and the metamorphosed core of the Rocky Mountains. Within this area are three important oil deposits. Turner Valley supplies a part of the oil needs of Western Canada, and has the distinction of being the oil field with the most complex structure in North America. Fort Norman, the northernmost of North American oil fields, supplies the radium and silver mining camps on Great Bear Lake. The Arhabasca tar sands contain a bigger reserve than any other single deposit—the estimate being 30 billion barrels. Most of the region is at a great distance from markets for petroleum products, so that development has not proceeded very fast.

General Geology

The province falls into two sharply contrasted parts. On the east side beds show a very low dip, down to 3 ft. per mile; it is somewhat obscured by glacial drift. The smaller area, on the west, is the foothill belt.

One of the major difficulties in exploration for oil in the foothill belt arises from the fact that the foothills are built of a number of almost horizontal thrust blocks. In many cases the thrust planes, as they approach the surface, break up into a number of smaller thrusts, and the dip steepens, so that no clean-cut thrust plane can be seen at surface. Further, the belt of disturbance which is the expression of the fault in such cases may be scoured out by ice action and by water, become filled with surface debris, and so become further obscured. In evaluating a structure as an oil prospect, closure and stratigraphy must both be considered. But it is also a critical matter to determine whether the probable reservoir rock exists within the thrust block, or if the drill would pass through the upper, barren part of the sequence, then through the thrust plane, and enter a lower block in which stratigraphic and structural conditions have no relation to those at surface.

This paper attempts to show that in the foothills area selected, study of the geomorphology from air photographs shows a considerable amount of detailed structure, and permits the drawing of probable boundaries separating three major thrust blocks.

Structure

East of the area shown on the map, almost horizontal beds can be observed along the Peace River. Within the area of the map, three areas of strikingly different structure are shown.

a) The easternmost block shows strong folding, with a NNW strike. The foremost (easternmost) fold is apparently a diapyre: structure elsewhere is ir-

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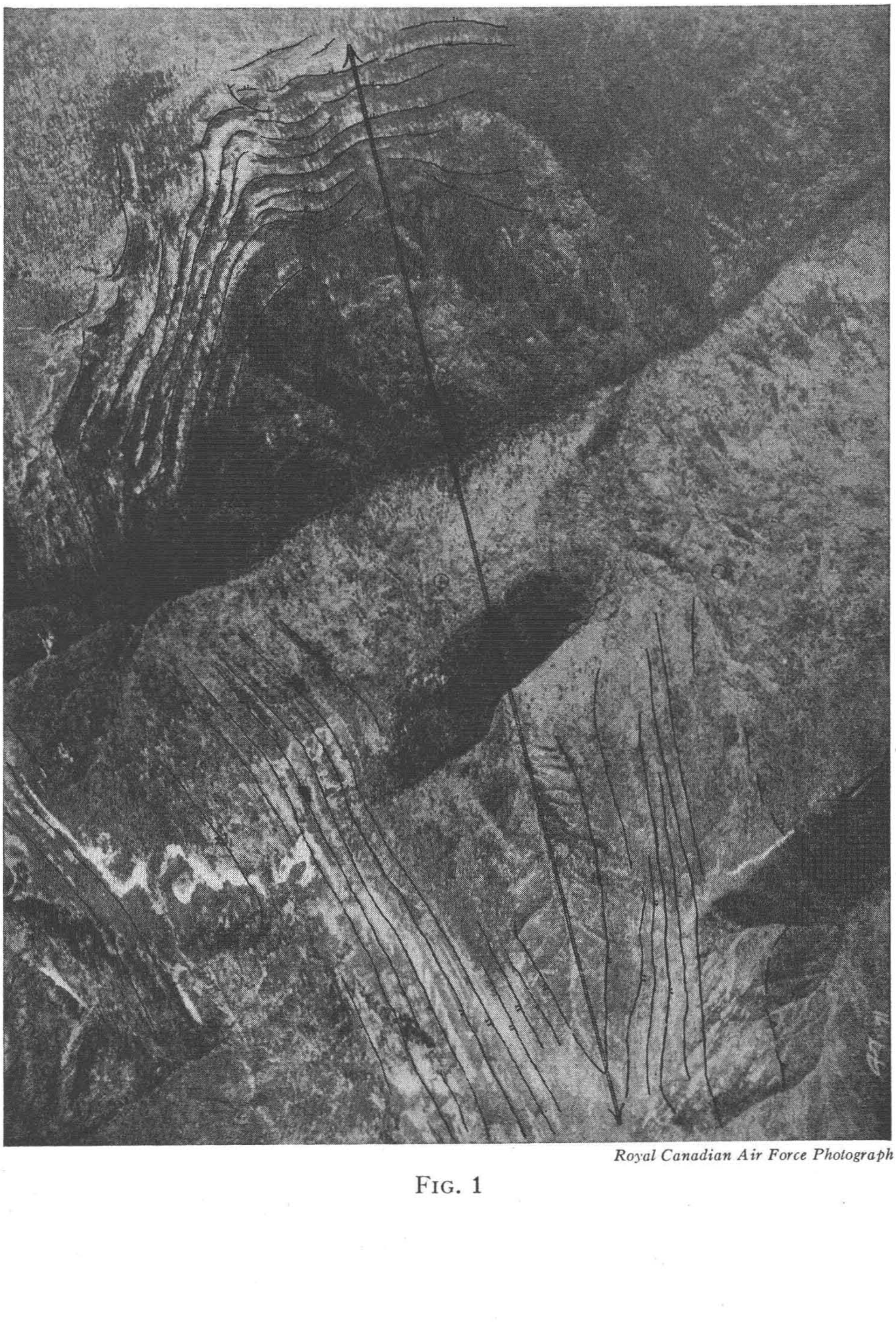
regular, some fault-strips parallel to the strike showing a very gentle dip.

b) The center block is a broad, gently folded dome, with some complications at its margin; capped, apparently, by the Bullhead Mountain Sandstone.

c) The western block shows sharp, symmetrical folds, striking almost north-south.



Royal Canadian Air Force Photograph

FIG. 1

Stratigraphy

The sequence of rocks as given by Hume[4] and others is

Lower Cretaceous	St. John	Black shale
	Bullhead Mountain	Hard Conglomeratic Sandstone
? Jurassic	Pine River	Black marine Shale
Triassic	Schooler Creek	Purple Limestone

Method

Photographs used were taken by the Royal Canadian Air Force, and were examined at the Victoria Museum in Ottawa. A simple mirror stereoscope was used.

Land-forms fall into two groups:

a) Constructional forms such as alluvial flats, beaches, sand dunes and the like. In a region dominated by constructional forms there is no detailed evidence for the underlying geological structure, since everything is covered by the recent deposits. It may be possible to outline recent structural movements in a broad way from the study of these recent deposits.

b) Destructional forms dominate most mountainous and hilly country. Where the agents of destruction are most active, they etch the surface of the earth, and bring out the structural relations by differential erosion of hard and soft beds. These relations are very clearly shown by air photos viewed under the stereoscope.

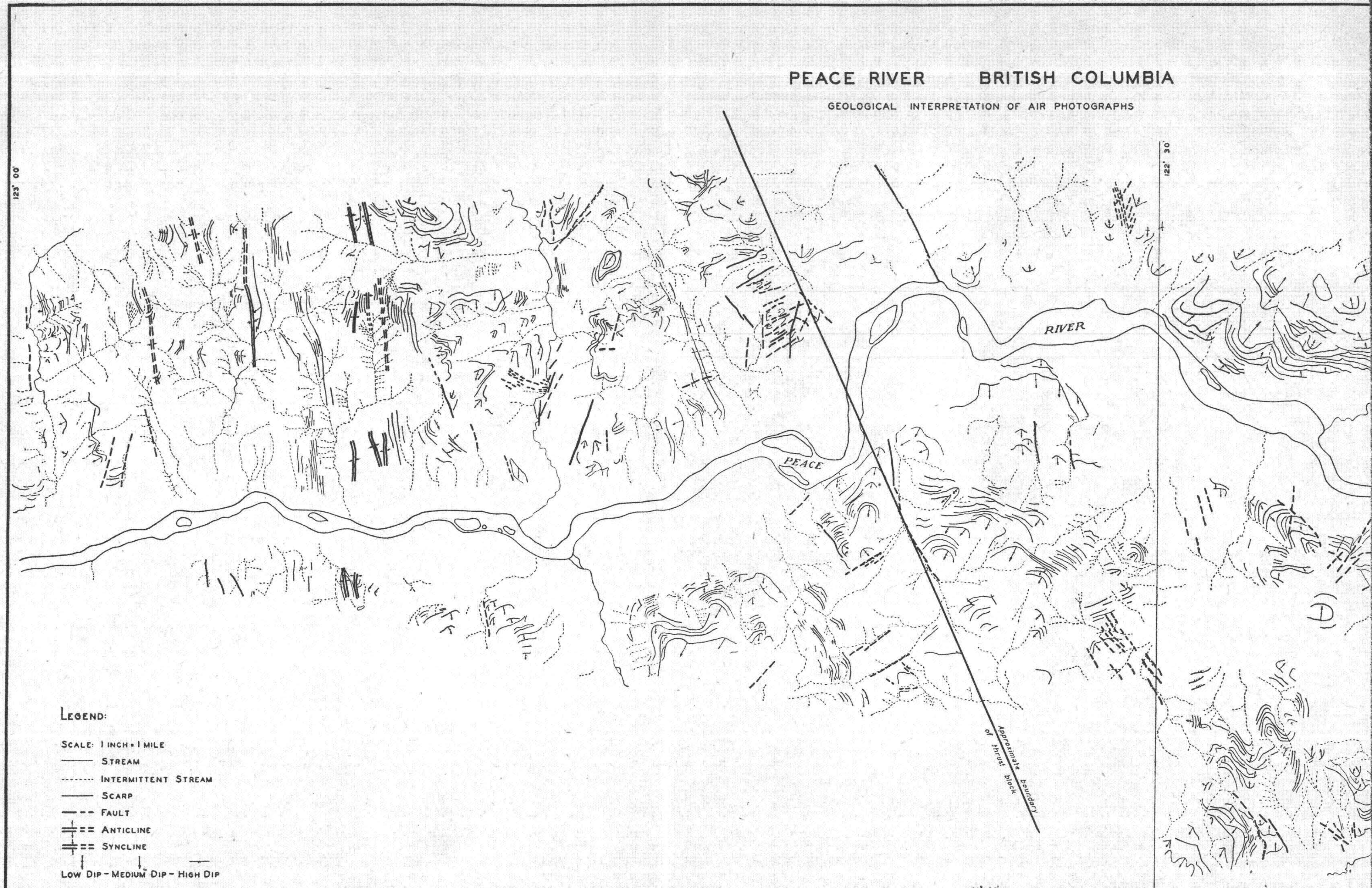
The area studied is a region of destructional land-forms. Two forms afford the principal structural evidence. In the Cretaceous rocks, strong cuestas are developed, with long, gentle slopes in the dip direction, and short steep slopes in the opposite direction. In the Triassic rocks the mountains are smoother, and individual beds are picked out by erosion, and photograph with the massive beds in a light tone, and the thin partings in a darker tone.

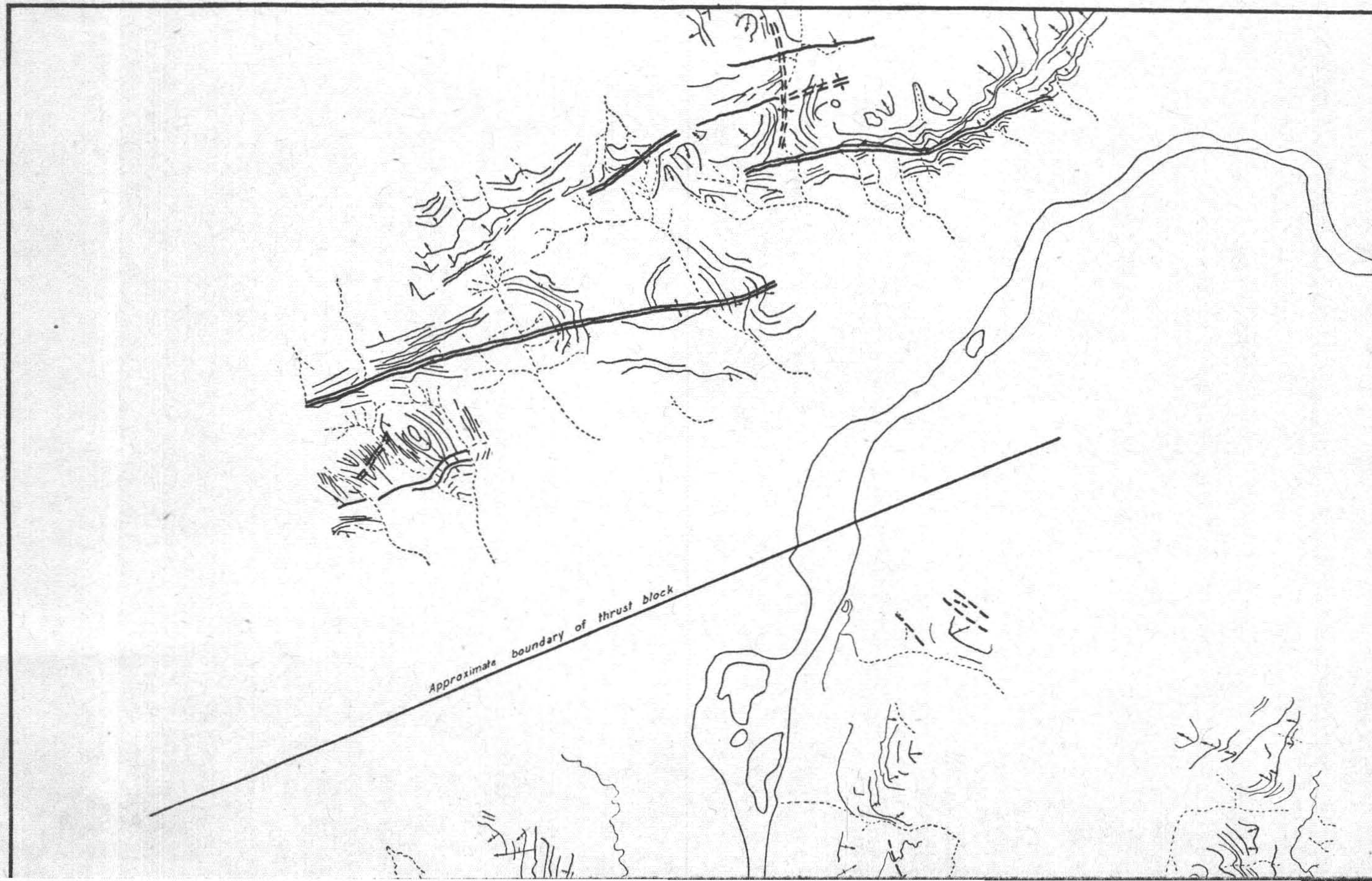
There is no adequate discussion in the literature of land-forms as seen under the stereoscope. But the methods of interpretation are an extension of principles accepted in geomorphology. An excellent basis for any such interpretation is found in the photographs and block diagrams by Lobeck.[5]

Survey Control

In compiling the map, the geomorphological features related to bedding, and the drainage channels, were traced off on Kodatrace under the stereoscope. Photographs of such mountainous country cannot be used to make uncontrolled mosaics. The Topographic Division of the Geological Survey had prepared a principal point plot. This was reduced to the scale of 1 inch to mile, as were the individual tracings of detail from the photographs. At this small scale, the discrepancies due to varying perspective distortion were small, and the detail was assembled into a mosaic.

A more complete study of the geometry of the complex folds of such a region requires the use of precision instruments. Thus, in the fold shown in the accompanying photograph (Fig. 1) the frontal fold of the mountains, it is possible that some portions of the steep flanks are overturned on both sides, so that at a high structural level the beds are dipping away from the axis, and at a lower level are dipping towards it: such a fold is a diapyre. Perspective distortion is such that


PEACE RIVER BRITISH COLUMBIA
GEOLOGICAL INTERPRETATION OF AIR PHOTOGRAPHS
123° 00'
122° 30'
58° 00'
PEACE
RIVER
Approximate boundary of thrust block
LEGEND:
SCALE: 1 INCH = 1 MILE
STREAM
INTERMITTENT STREAM
SCARP
FAULT
ANTICLINE
SYNCLINE
LOW DIP - MEDIUM DIP - HIGH DIP


Approximate boundary of thrust block

the dips of nearly vertical beds cannot be determined with a simple stereoscope, and it is necessary to determine the ground co-ordinates of points at different elevations on the same bed.

SUMMARY

Paper gives some geological observations on air photographs of the Peace River, in an attempt to outline the boundaries of the major thrust blocks, and determine the structure of each block. It illustrates a method of interpretation, which, it is suggested, should run concurrently with photogrammetric work when an air survey is made of an area in which oil is to be expected.

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