

STATE DEPARTMENT OF GEOLOGY AND
MINERAL INDUSTRIES

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BULLETIN NO. 5

Geological Report on part of the
CLARNO BASIN
WHEELER AND WASCO COUNTIES, OREGON
1938

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STATE GOVERNING BOARD

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Speaking in general, the existence of any oil field is normally based on certain requirements. There must be a structure - an anticline, or dome, or terrace, to serve as an accumulation area for oil. There must be an oil "sand" that is a rock stratum, - sandstone, limestone, or other rock, - which has sufficient porosity to contain oil and gas, and at the same time allow oil and gas to migrate through it. There must be a "cap rock" which is an impervious bed serving to hold the oil or gas down under the structural area of accumulation. This "cap rock" must not be faulted to such an extent as to allow the dissipation of any oil which may at one time have been present. It is true that in some oil fields faulting has served to trap oil and gas because of the impervious zone sometimes developed along the fault plane. Whether or not a fault will allow oil and gas to escape, or on the other hand will seal the structure, will be determined by the nature of the rock shattered by the faulting. Last and most important, there must be oil present in the area in question, or in the surrounding rocks, otherwise it would not accumulate even if all other conditions were favorable. The absence of any of the requirements above would preclude the development of an oil field in this area.

Whether or not the surface structure mapped corresponds to the sub-surface structure of the supposedly petroliferous strata, is not known, because of the probability of unconformity between the underlying beds which are of different ages.

In the case of the Clarno Basin, the plane table survey by Mr. Mackay has demonstrated the presence of a structure. The structure is in the form of a narrow terrace with rather small closure. In this structure a saddle separates two apparent "highs". The Clarno well was drilled to a depth of more than 4500 feet, well up on the terrace but on neither of the "highs".

In my opinion, the Clarno oil well, although not located at the most desirable point, nevertheless was drilled at a point on the structure, which would probably assure it some production if the structure itself is ever to become a field. We have therefore suggested to the Corporation Commissioner that he approve the sale of not to exceed \$25,000 in securities by the Clarno people for the purpose of making a test of this hole, with the proviso that such funds shall not be used for the purpose either of deepening the present hole or of drilling a new one.

The fact that the Clarno Company has spent a tremendous amount of money without a satisfactory answer has had some bearing on our conclusion, that a test of the well is justified. If the test is negative, we are inclined to doubt if it would be advisable to spend any more money in drilling the immediate area. It is our feeling, based on present information, that a perfectly dry hole here would serve to eliminate the Clarno area from further drilling expense.

Earl K. Nixon, Director.

State Department of Geology
and Mineral Industries,
704 Lewis Building, Portland, Oregon,
February, 1938.

SUMMARY.

At the request of the Director of the State Department of Geology and Mineral Industries, a planetable survey was made in November and December, 1937, of the area surrounding the Clarno well located about 2 miles east of the bridge which crosses the John Day River at Clarno, Oregon. The purpose was to determine the nature of the geologic structure so that there would be some basis for an opinion as to whether or not oil companies should be permitted to sell stock to the public to finance their drilling operations in this area.

The survey was confined largely to the Clarno formation of upper Eocene or lower Oligocene age, over an area of some 20 square miles in Wheeler and Wasco Counties. The geologic section was found to consist of an upper series of tuffs, basalt and andesite flows, breccias and agglomerates which rest unconformably on a conglomerate series which in turn rests unconformably upon a basalt flow. These unconformities are not angular, the beds being parallel or nearly so.

An andesite flow in the upper series of volcanic rocks and two strata in the underlying conglomerate series were used as markers. The andesite flow or upper key bed was chosen as the datum level on which the contours are based.

The contour map shows the existence of a structural terrace about $1\frac{1}{2}$ miles wide on a monocline which dips some 5 degrees or more towards the northwest. The structural terrace is not uniformly level but contains two small "highs" and a "low" in the area mapped. The Clarno well, which has been drilled to a depth of over 4500 feet, is located in the structurally low area on this terrace.

The structural terrace is not regarded as especially favorable for oil accumulation though oil may be found along it in the "highs" referred to. The structure is of such small dimensions that if oil were found only a relatively small field would result and this type of enterprise should not be financed through the sale of stock to the public.

The Clarno Oil Company reports good showings of oil and gas in its well. Officials of the company state that the condition of the hole is sufficiently satisfactory to enable them to test these showings and they are planning to do this. The well is very poorly located but in view of the fact that it is on the edge of the structural terrace they should be allowed to make this test. It is not recommended that the Clarno Oil Company be permitted to sell stock to the public for the purpose of deepening this hole.

INTRODUCTION.

The area described in this report is located near Clarno, Oregon, and lies on both sides of the John Day River. It includes some 15 square miles east of the river in Wheeler County and about 5 square miles west of it in Wasco County. A well drilled by the Clarno Oil Company to a depth of over 4500 feet on Pine Creek about 2 miles east of the Clarno bridge, occupies a central position within the area.

Clarno is accessible by a country road connecting Antelope and Fossil, being about midway or roughly 20 miles from each of these towns. This road while satisfactory for automobile traffic in the dry season becomes nearly impassable after heavy rains. The nearest point on the railroad is Shaniko, situated on a branch line of the Union Pacific, 8 miles from Antelope.

The purpose of the investigation was to determine as far as possible the geologic structure, in order that the State Department might decide whether or not sufficient justification exists to warrant granting permits to sell stock to the public to those desirous of drilling for oil in the area.

The methods employed were those generally used to determine the structure of strata. A rapid reconnaissance was first made and key beds selected which were then mapped by means of the planetable and alidade. Elevations obtained on the various beds were, of course, referred to a single key bed and the map contoured according to the figures obtained for that datum level.

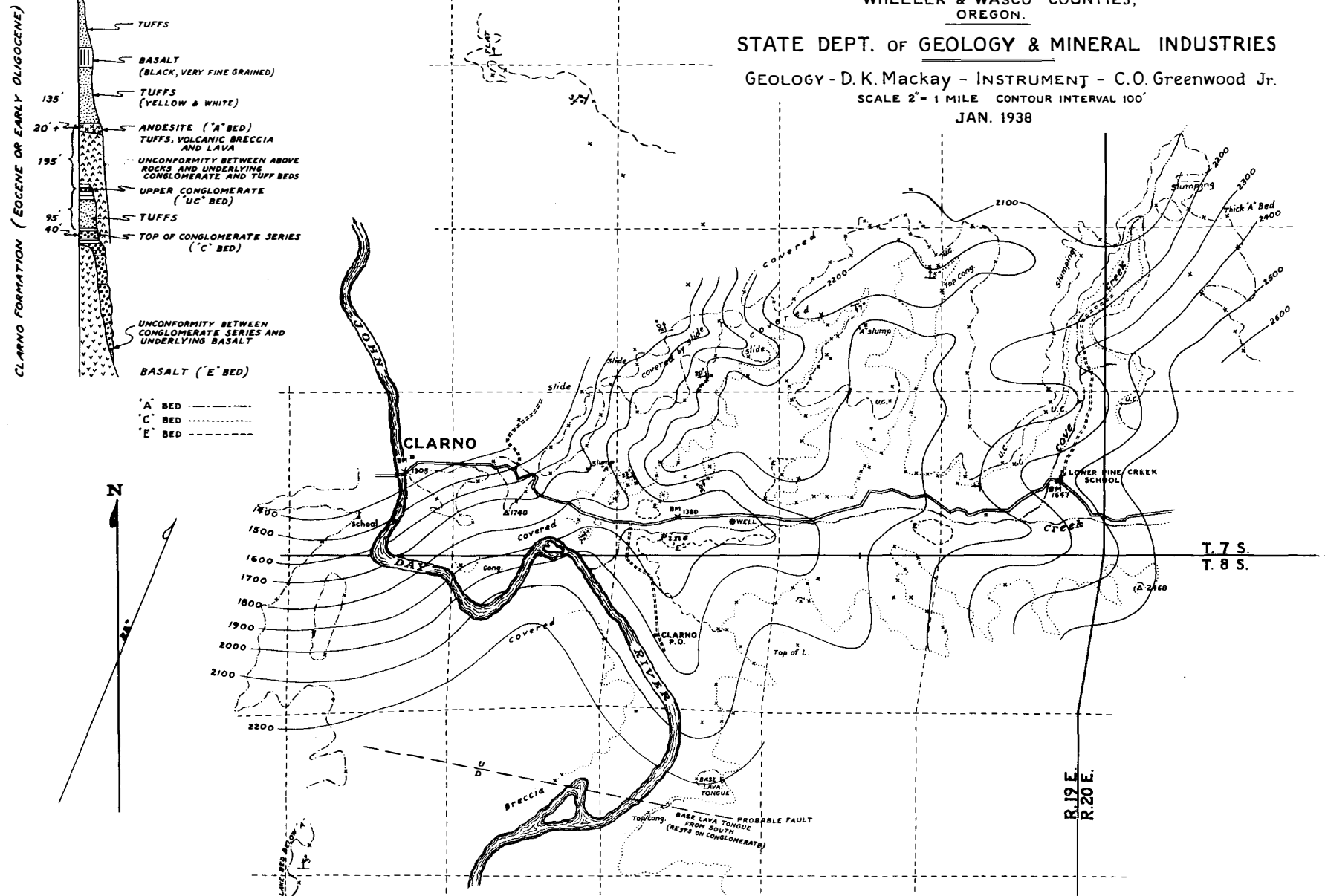
Surveying was done during parts of November and December, 1937. Some delay was occasioned by heavy rains during this period.

PHYSICAL CONDITIONS.

Topography:

The John Day Valley is more than 5 miles wide and 2000 feet deep in this region. Its upper walls are steep cliffs of Columbia River basalt below which there is a relatively gentle slope towards the river developed in the underlying soft John Day tuffs. In and near the valley floor the more resistant rocks of the Clarno formation outcrop. These consist of both hard and soft beds generally more or less tilted and greatly dissected by erosion, producing a rugged topography as contrasted with the John Day Tuffs.

JAN. 1938



Most of the area mapped lies within the Clarno formation. Differences in elevation were found ranging from 1300 feet on the John Day River at Clarno to over 2600 feet on the scarp northeast of the Pine Creek schoolhouse, a relief of about 1300 feet.

An interesting feature is a hill west of the John Day River from Clarno (right foreground Fig.3) which is capped by a thin lava flow tilted towards the west. Following the extension of this bed eastward across the river north of Pine Creek, it is found to produce a "hogback" for a considerable distance towards the northeast.

Another topographic feature of the area is found south of Pine Creek and east of the John Day River where the lava flows have attained considerable thickness. The plateau produced by them dips more gently than the aforementioned bed, is greatly dissected and bound by steep scarps along the John Day River.

Underlying the lava flows there is a series of conglomerates which includes some tuffaceous beds. The conglomerate strata frequently form benches. Where the hard beds overlie softer ones weathering has produced grotesque shapes. For instance, a thin pillar of conglomerate may often be seen supporting a large slab of the overlying bed: and in other ways differential weathering within the conglomerate series has produced some striking erosional forms.

Drainage and Vegetation:

The drainage of the area is towards the John Day River via westward and eastward flowing tributaries. Most of these are of the intermittent type, containing no water during the dry season. Bottom lands along these creeks and the John Day River are farmed but the chief industry consists in raising sheep and cattle which feed upon the short grass found over most of the area. There is some sage brush and a few junipers. Wood for building or fuel must be obtained outside the district.

Exposures:

Outcrops of the lava flows are continuous for considerable distances. The underlying beds are not so well exposed, however, and the key beds in the conglomerate series are frequently masked by a cover of soil. Such is the case, for example, along the scarp south of Pine Creek. At a few points the key beds in the conglomerate series could not be determined with precision and elevations were obtained which are approximately correct.

GEOLOGIC CONDITIONS.

Stratigraphy:

The geologic section for the area has been indicated diagrammatically on the planetable sheet. It is, briefly, as follows:

<u>Thickness</u>	<u>Character of rocks</u>
?	Thick tuff series
50'	Very fine-grained black basalt, in places almost obsidian
135'	Yellow and white tuffs (south of Pine Creed breccia and lava)
20' plus	Andesitic lava bed varying in color (black, red, gray) which increases in thickness in places but is about 20' thick for a considerable distance. Called "A" bed; is shown as indicated on the map; and is the datum level on which the contours are based.
190' plus	Ashy beds, indurated in places to tuffs, glomerates, breccias, lava. - unconformity (disconformity) -
95'	Tuff bed 20' Upper conglomerate bed 15' approx., called "UC" bed Tuffs 60'.
60-600'	Conglomerate series; upper bed called "C" series contains ash and some tuffaceous beds; is shown in dotted line on map. - unconformity - (probably disconformity)
200' plus	Basalt: called "E" bed; shown in dashed line on the map.

The basal member of this section to which the field name basalt is given is well exposed at several localities along Pine Creek. It is evident that there were hills and valleys developed on the surface of this bed before the conglomerates were deposited and that during deposition the hills stood out as islands for a time and were eventually covered by the conglomerates. A good example of this unconformity may be seen a few hundred yards north-east of the Clarno well where the thickening of the conglomerate series on the flank of this hill may be readily traced.

Pebbles and boulders of the conglomerate series are volcanic rock, chiefly basalts and andesites, and vary in size from very small to a foot or more in diameter. All are somewhat angular but show rounding. The two upper conglomerate beds with their interval of about 95 feet served as key beds.

There are 190 feet of tuffs, agglomerates and breccias between the upper conglomerate and "A" bed which appear to lie conformably on the conglomerates over a large part of the area mapped. However, evidences of unconformity (disconformity) at the top of the conglomerates exist in the following localities and this series thickens to include lava.

On the east wall of the John Day gorge and south of the fault indicated on the plane table sheet and in Fig. 5, on the south edge of area mapped, a tongue of lava is found occupying a depression in the conglomerates where the "U" and "C" beds should occur. Also, on the scarp west of Clarno (right background, Fig. 3) the conglomerates are not present below the "A" bed where they should occur and andesite tuffs are found instead. About 3/4 mile above the Clarno bridge on the John Day River the interval between the highest conglomerate outcrop and the "A" bed is excessive, indicating that the upper conglomerates are missing.

Over a considerable part of the area mapped the conglomerates appear conformable or nearly so with the overlying beds as determined by checking the intervals to the "A" bed at several localities. Mapping of the conglomerate series was discontinued wherever any doubt existed regarding the key beds. Therefore the unconformity (disconformity) mentioned does not affect the mapping of the structure as far as this work has been carried.

It should be noted also that the tuffs, breccias and agglomerates between the conglomerates and "A" bed show considerable lateral variation. In some places as at the pass over the "hogback" between the well and Clarno bridge soft tuffs may be seen grading into indurated beds which stand out prominently on the scarp.

The overlying "A" bed appears from field examination to be andesite. It is persistent and can be followed continuously for some ten miles across the western and northern portion of the area where it is about 20 feet thick for a considerable distance. It thickens toward the east and to the south grades above and below into either breccia or lava.

The tuff series overlying the "A" bed is well defined in the northeastern part of the area as is the 50 foot basalt bed above it. However, elevations were taken on the latter merely for the section and to verify the dip and the beds are of little importance as far as the present work is concerned.

No estimate was made of the great thickness of the series of tuffs at the top of the section (which appears to contain no recognizable key bed) since they lie outside the limits of the area surveyed. A few elevations were taken on the base of a basalt bed at the top of this series to indicate the normal dip found in a locality to the northwest of the area.

Structure:

Figures 1, 2, 3, and 4 are photographs of a portion of the area surveyed taken from a point on the "A" bed approximately $\frac{1}{2}$ mile southeast of Clarno bridge. The complete panorama through 360 degrees visible from this station is shown and except in one instance the photographs connect with one another closely.

In Fig. 1 the "A" bed will be seen capping the ridge of "hogback" extending towards the northeast and the steep northwest dip of this bed is evident on the left side of the photograph. This steep dip of the "A" bed towards the northwest may also be seen in the right background of Fig. 3, to which reference has already been made.

Elevations were taken on the "A" bed over the western and northern half of the area where the bed is of fairly constant thickness and can be followed continuously but in the southern part tuffs and breccia beds above and below the "A" grade into lava and the "A" is no longer a clean-cut marker. Elevations were run on the underlying key beds in the conglomerate series in that locality.

The conglomerate series is not apparent in the photographs. It occurs, however, in the slope to the river below the lava cap on the left of Fig. 2. The best point to observe the series is in the northeast corner of Section 26 about two miles northeast of the Clarno well. The upper conglomerate bed is 190 feet below the top of the "A" bed and the lower conglomerate bed is 95 feet below the upper conglomerate bed. Occasionally elevations were taken on well exposed beds occurring immediately below or above these markers. All elevations taken in the conglomerate series were calculated in terms of the datum level (the "A" bed) and the plane table sheet was then contoured. The contour map is nearly self-explanatory and only a brief discussion of the structure will be given below.

Reference to the contours will show that a structural terrace roughly $1\frac{1}{2}$ miles wide exists between two steep northwest dips. This terrace is not uniformly level but contains two structural "highs" and a "low" in the area mapped.

One structural "high" on the terrace lies in the northern part of the area. It is located in the north half of section 26 and extends into northwest 25. It has the form of a small irregularly shaped anticline little more than a mile long in an east west direction and is about $\frac{1}{4}$ mile wide. The closure in this small fold is less than 100 feet.

The other structural "high" on the terrace is located at the southern edge of the area mapped, in the north half of section 9. It extends nearly a mile in an east west direction and appears to be terminated on its south side by a fault. Since the conglomerate key beds are not present in this locality due to unconformity (disconformity) and lava and breccia rest on the lower conglomerates of the series, it is difficult to be certain that the points shown in Figs. 5 and 6 are entirely due to faulting. This evidence, however, and the contours suggest that a small fault of about 100 feet displacement, with downthrow to the south, terminates this small "high" on the south side.

ECONOMIC CONSIDERATIONS.

Organic marine sediments, the source beds of oil, are believed to be present beneath the Clarno formation in this area. There is, however, but little information available on this subject. Cores from the Clarno well were sent to Oregon State College last fall and a report on these specimens - which should throw some light on the matter - has not yet been received.

On October 12, 1937, E. R. Millett, Jr. petroleum engineer of Venice, California, in a report on the Schlumberger electrical log of the Clarno well, stated:

"From 2025-2200 a possible zone (oil or gas) is present. A slight weakness shows in porosity between 2105 and 2120 but not sufficient to cause any trouble. This zone is a sandy shale bearing some oil and gas. It is not a tar zone because a tar zone shows a more rounded chart on the Schlumberger resistivity log. This zone being in the upper Cretaceous should be productive on structure. At present the zone has very little gas in it and is typically an edge condition." "In summing up the log the only interval of interest is 2025 to 2200. The electrical log shows clearly and definitely that there is a petroliferous zone in the Clarno area which should be productive. The oil produced from this zone should be fairly high gravity and good grade."

On the basis of present knowledge it is reasonable to suppose that the Cretaceous underlies the Clarno, as Mr. Millett states. There is an unconformity between the Clarno and the formation below it and the strata of the two formations are probably not parallel. However, the structure at the surface reflects to some extent the deformation in the older rocks.

Assuming the source rocks of oil to be present, there are according to the drillers' log of the well a sufficient thickness of porous strata overlain by impervious beds to trap oil on favorable structure.

A structural terrace is, however, not a particularly good structure for oil accumulation but some oil may be found along it under the two "highs". These are, however, of such small dimensions that it is doubtful whether they are worth testing in view of the excessive drilling costs in this area.

CONCLUSION.

The Clarno Oil Company is planning to test its well in the near future in an attempt to prove the presence of a small quantity of oil and gas. The well is very poorly located - in a "low" on the structural terrace - but in view of the fact that it is on the edge of this structure they should be allowed to make this test. It is not recommended that the Clarno Oil Company be permitted to sell stock to the public for the purpose of deepening the hole, since drilling costs below 4500 feet are extremely high and the chance of success small.

While some justification exists for testing the two "highs" on the terrace, the structure is of such small dimensions that if oil were found only a small field would result and this type of enterprise should not be financed through the sale of stock to the public.

NORTHEAST

EAST



FIG. 1. Left side of photograph shows the steep northwest dip in the "A" bed capping the ridge or "hogback". The right half shows Pine Creek valley in the center of which the Clarno well is barely discernible. The scarp to the right of the well is covered with soil and contains few good outcrops of key beds.

PHOTOGRAPHS TAKEN FROM A POINT ON THE "A" BED ABOUT ONE-HALF MILE SOUTHEAST OF CLARNO BRIDGE (Capital letters above the photographs indicate the direction of the view from that point).

SOUTHEAST

SOUTH



FIG. 2. Looking up the John Day valley---shows to the left of the river a scarp capped by lava under which lie the conglomerate series. The lower bench in the center of the photograph is the end of a tongue of lava from the south which rests directly on the lower portion of the conglomerate series (p. 5 par. 3).

PHOTOGRAPHS TAKEN FROM A POINT ON THE "A" BED ABOUT ONE-HALF MILE SOUTHEAST OF CIARNO BRIDGE (Capital letters above the photographs indicate the direction of the view from that point).

SOUTHWEST

WEST



FIG. 3. Shows steep dip in "A" bed in right background (p. 3 par.2). Note in foreground tuffs underlying the "A" bed which in places are poorly consolidated. Sliding of the "A" bed sometimes occurs due to the softness of these underlying beds but such slides are not numerous and are readily recognizable.

PHOTOGRAPHS TAKEN FROM A POINT ON THE "A" BED ABOUT ONE-HALF MILE SOUTHEAST OF CIARNO BRIDGE (Capital letters above the photographs indicate the direction of the view from that point).

NORTHWEST

NORTH

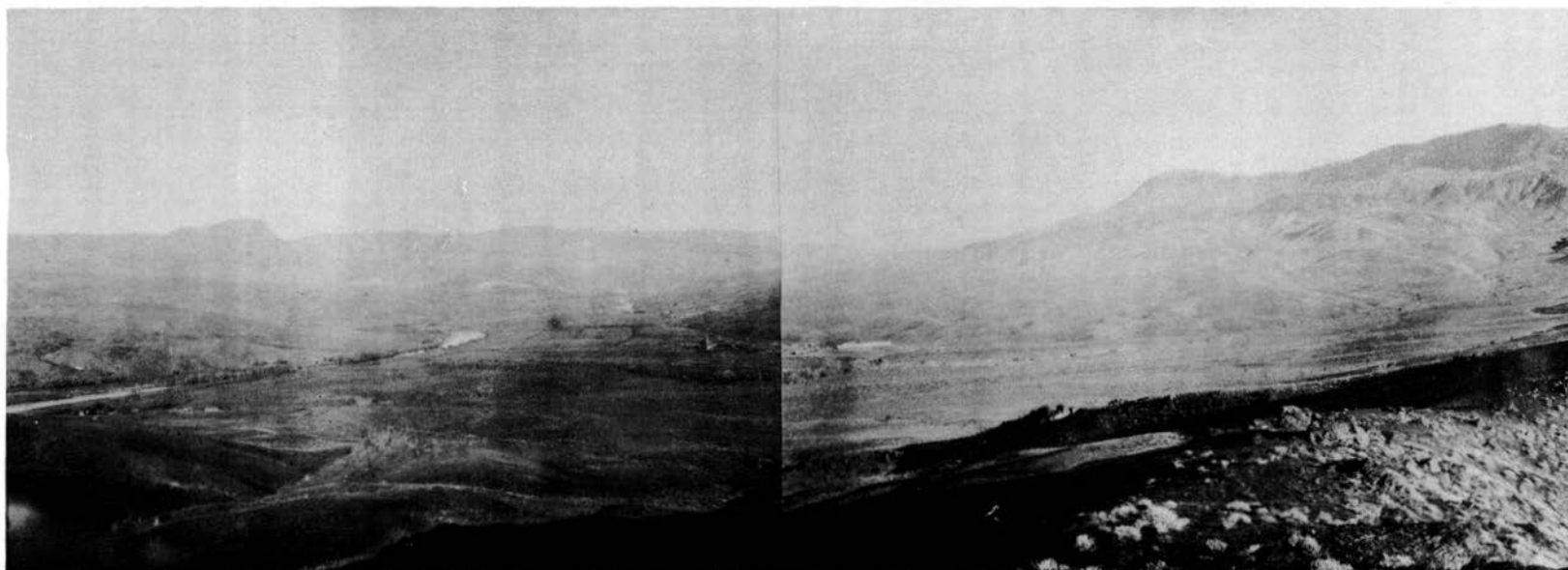


FIG. 4. Looking down the John Day valley into a wide area of John Day tuffs. Note the resistant caps on the skyline, which are Columbia River basalt.

PHOTOGRAPHS TAKEN FROM A POINT ON THE "A" BED ABOUT ONE-HALF MILE SOUTHEAST OF CLARNO BRIDGE (Capital letters above the photographs indicate the direction of the view from that point).



FIG. 5. East scarp along John Day river at south edge of area mapped. Shows tongue of lava from south resting on lower conglomerates, the conglomerate key beds being absent due to unconformity (disconformity). Note the apparent displacement at the base of the lava.



FIG. 6. Located west of Fig. 5, on west side of John Day river. Note south dip (drag on upthrow side of fault?) in lower conglomerate bed. The rocks to the left (south) of this dip are volcanic breccias.

ADDENDA.

- P.6, line 1. Should read, "In Fig.1, the 'A' bed will be seen capping the ridge on 'hogback' extending toward the northeast and the steep northwest dip of this bed is evident on the left side of the photograph. This same steep dip of the 'A' bed may also be seen in the right background of Fig.3."
- P.6, line 2. (instead of first sentence) "The conglomerate series is not apparent in the photograph. It occurs in the slope to the river below the lava cap shown on the left of Fig.2."

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