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SUBSURFACE GEOLOGY OF THE HANFORD SEPARATION AREAS

By

D. J. Brown

Geochemical and Geophysical Research
Chemical Effluents Technology
CHEMICAL RESEARCH AND DEVELOPMENT

HANFORD LABORATORIES OPERATION

October 1, 1959

HANFORD ATOMIC PRODUCTS OPERATION

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SUBSURFACE GEOLOGY OF THE HANFORD SEPARATION AREAS

By

D. J. Brown

INTRODUCTION

The region in which Hanford's chemical processing plant areas (separation areas) are located is the central portion of the Hanford Works area on a plateau, shaped like a giant bar, of glaciofluviatile materials. The general location of these areas is shown in Figure 1. The region studied rises from 200 to 300 feet above the surrounding area and encompasses approximately 40 square miles or somewhat less than 8% of the Hanford reservation (Figure 2). Within the region are located the chemical separation plants and most of the major waste disposal sites.

Subsequent to an initial geological exploration by the Corps of Engineers the region was studied by geologists of the U. S. Geological Survey and of the General Electric Company, to determine the feasibility of the disposal of radioactive wastes to the ground (1, 2, 3). As data accumulated from the continued construction of wells in the region this earlier work was refined to show the geology more in detail. The purpose of this report is to summarize this detailed information on the subsurface geology of a part of the Hanford Works. This is done primarily by the use of geologic cross sections. The correlative work between the different wells mentioned in this report consists of the determination of lithologic characteristics and the equivalent succession of beds. The definitions of the various sedimentary materials described are those adopted by the National Research Council (4).

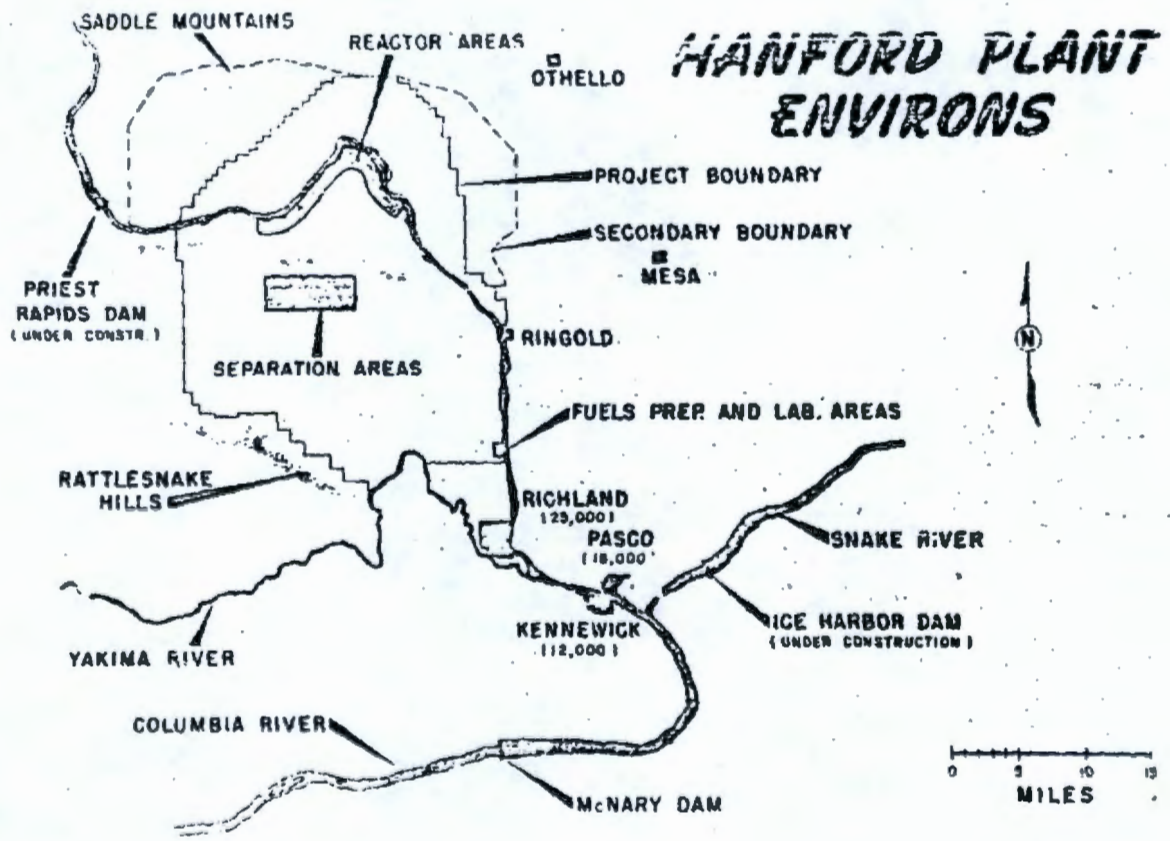
HANFORD PLANT ENVIRONS
SADDLE MOUNTAINS
REACTOR AREAS
OTHELLO
PROJECT BOUNDARY
SECONDARY BOUNDARY
MESA
PRIEST RAPIDS DAM (UNDER CONSTR.)
SEPARATION AREAS
RINGOLD
FUELS PREP. AND LAB. AREAS
RATTLESNAKE HILLS
RICHLAND (25,000)
PASCO (18,000)
SNAKE RIVER
ICE HARBOR DAM (UNDER CONSTRUCTION)
KENNEWICK (12,000)
YAKIMA RIVER
COLUMBIA RIVER
McNARY DAM
N
0 5 10 15
MILES

FIGURE 1

GENERAL ELECTRIC
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HANFORD ATOMIC PRODUCTS OPERATION
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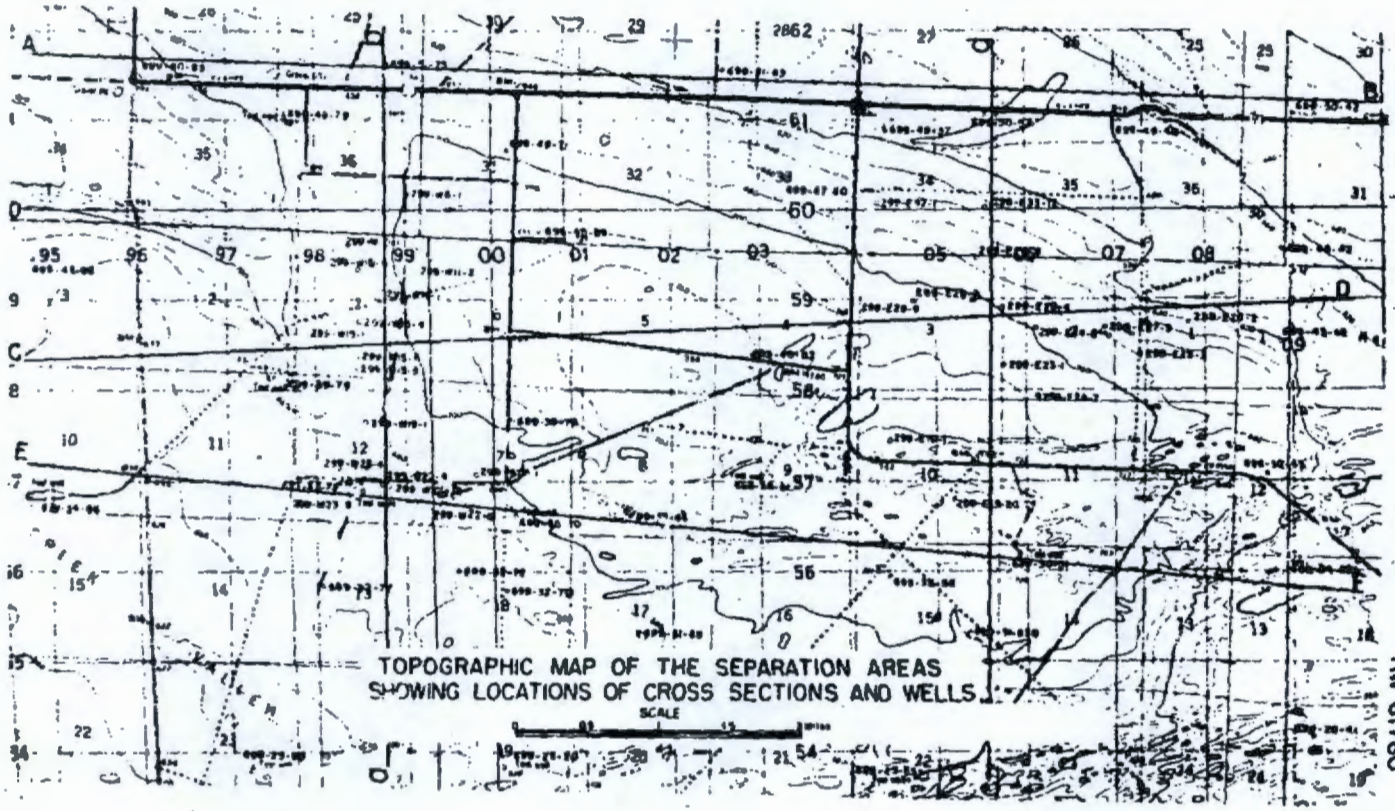

FIGURE 2

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SUMMARY

Five geologic units are known beneath the region in which Hanford's chemical processing plants are located. In ascending order these include the Columbia River basalts and the interbeds of the Ellensburg formation in the upper part of the basalt series, the Ringold formation, Palouse soil, and a thick deposit of fluviatile and glaciofluviatile sediments.

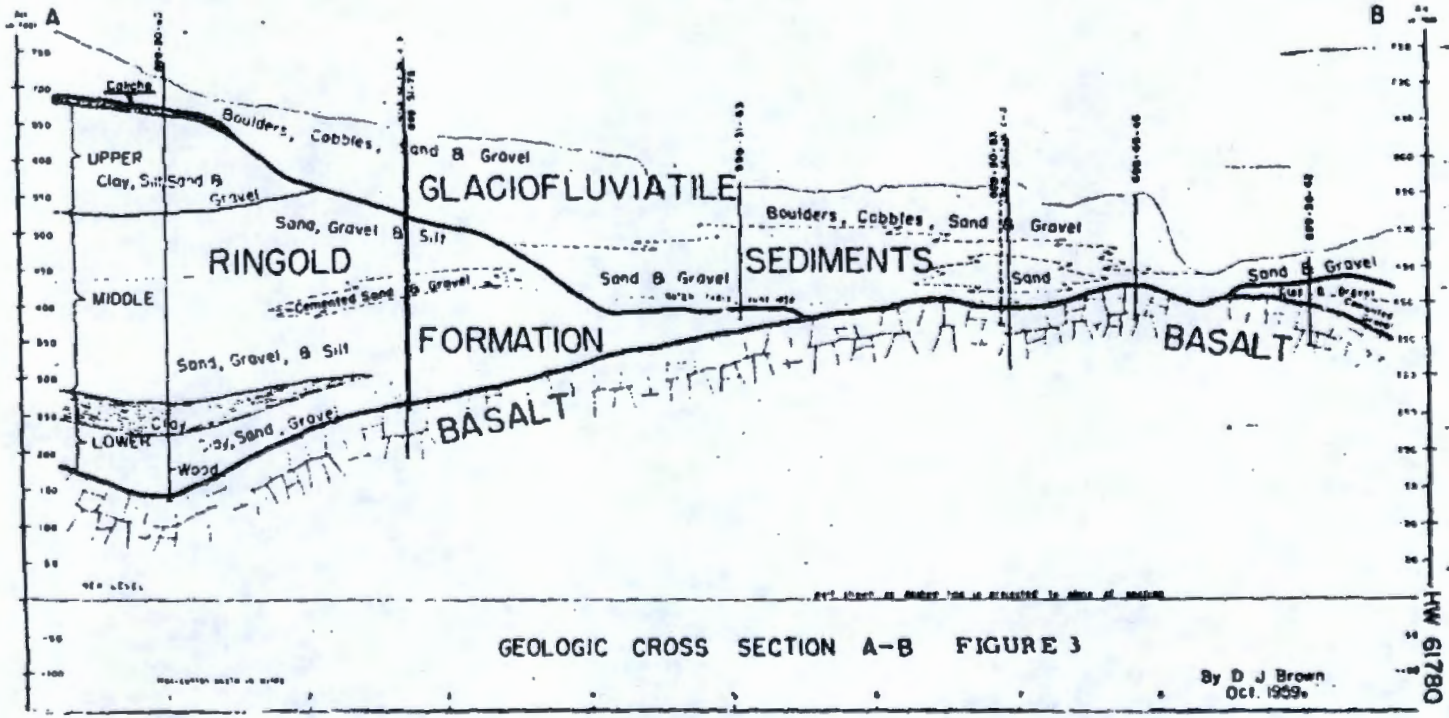
The Columbia River basalts form the bedrock beneath the separation areas. Overlying the basalts and largely conformable with them are several hundred feet of lacustrine and fluviatile sediments known as the Ringold formation. Three lithologic zones of the Ringold formation are characterized by their designation of: lower "blue clay" zone, middle conglomerate zone, and upper silt zone. Capping most of the Ringold formation is a thick layer of calcium carbonate or caliche, representing an old land surface. Unconformably overlying the Ringold formation in the western part of the areas is an eolian deposit correlated to the Palouse soil of eastern Washington. Above this deposit, and also unconformable with the Ringold formation, are several hundred feet of glaciofluviatile sediments. These are coarse materials made up largely of sands, gravels and boulders.

The basalts, interbasalt sediments, and the Ringold formation are measurably though not greatly tectonically deformed.

STRATIGRAPHY

Columbia River Basalts

Underlying the surficial deposits everywhere beneath the region are the Columbia River basalts, which form the bedrock. Insofar as the basalts are essentially



GEOLOGIC CROSS SECTION A-B FIGURE 3

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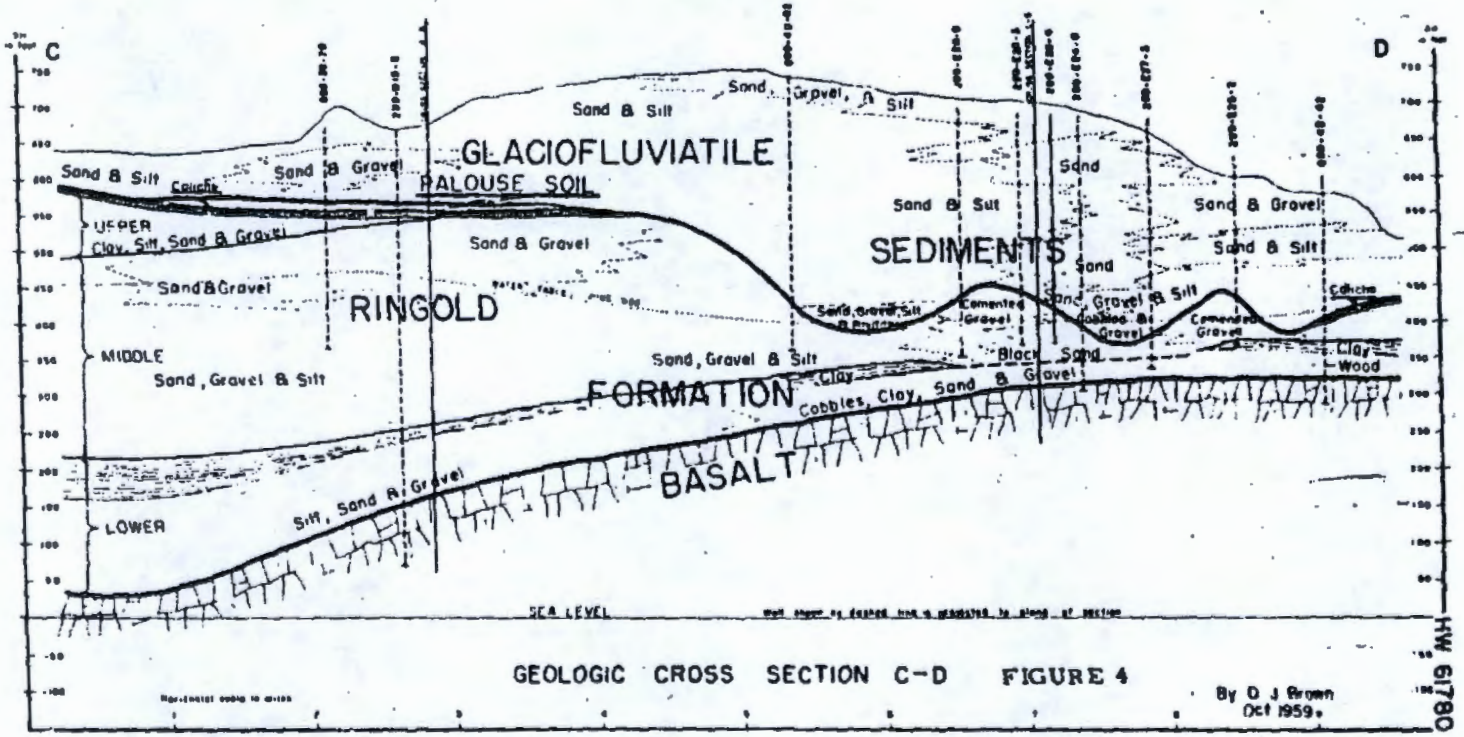

GEOLOGIC CROSS SECTION C-D FIGURE 4

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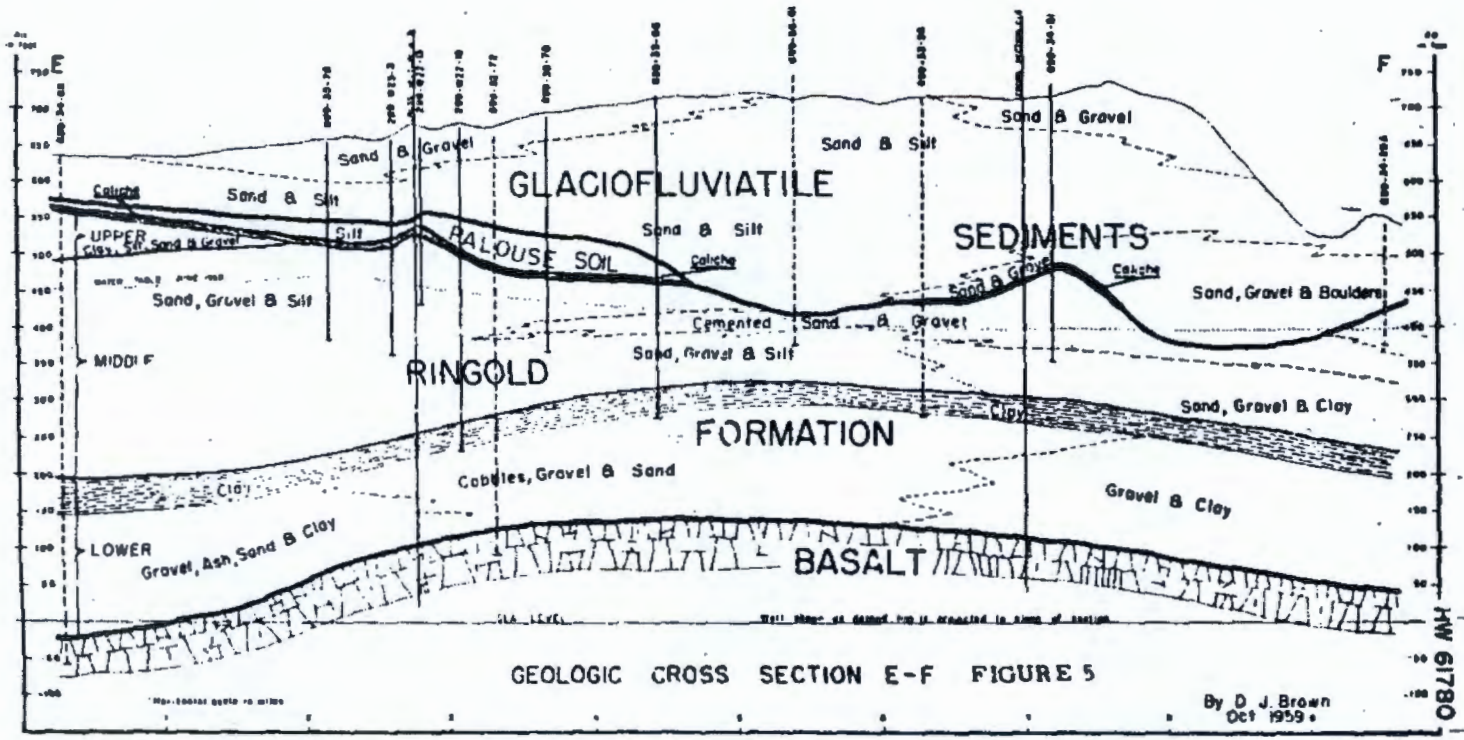

GEOLOGIC CROSS SECTION E-F FIGURE 5

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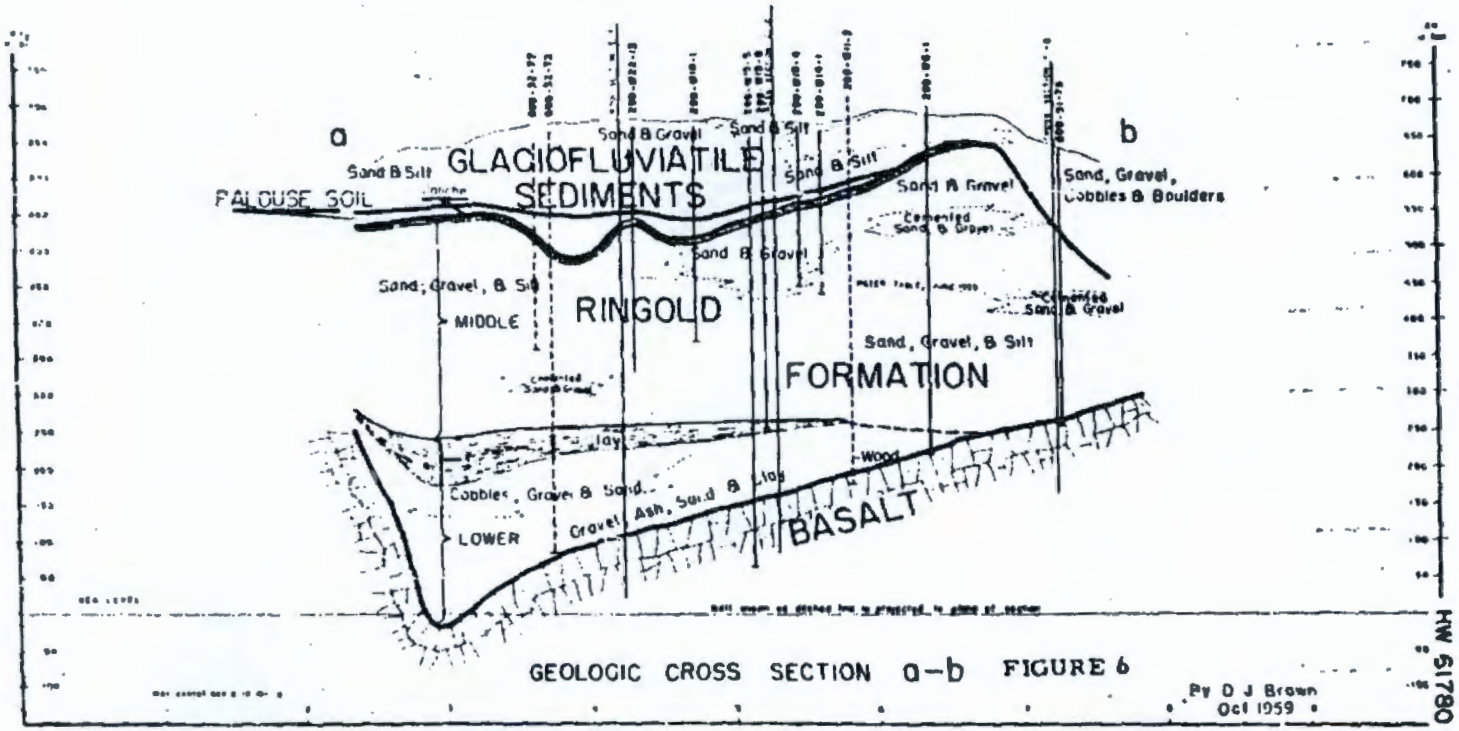

GEOLOGIC CROSS SECTION a–b FIGURE 6

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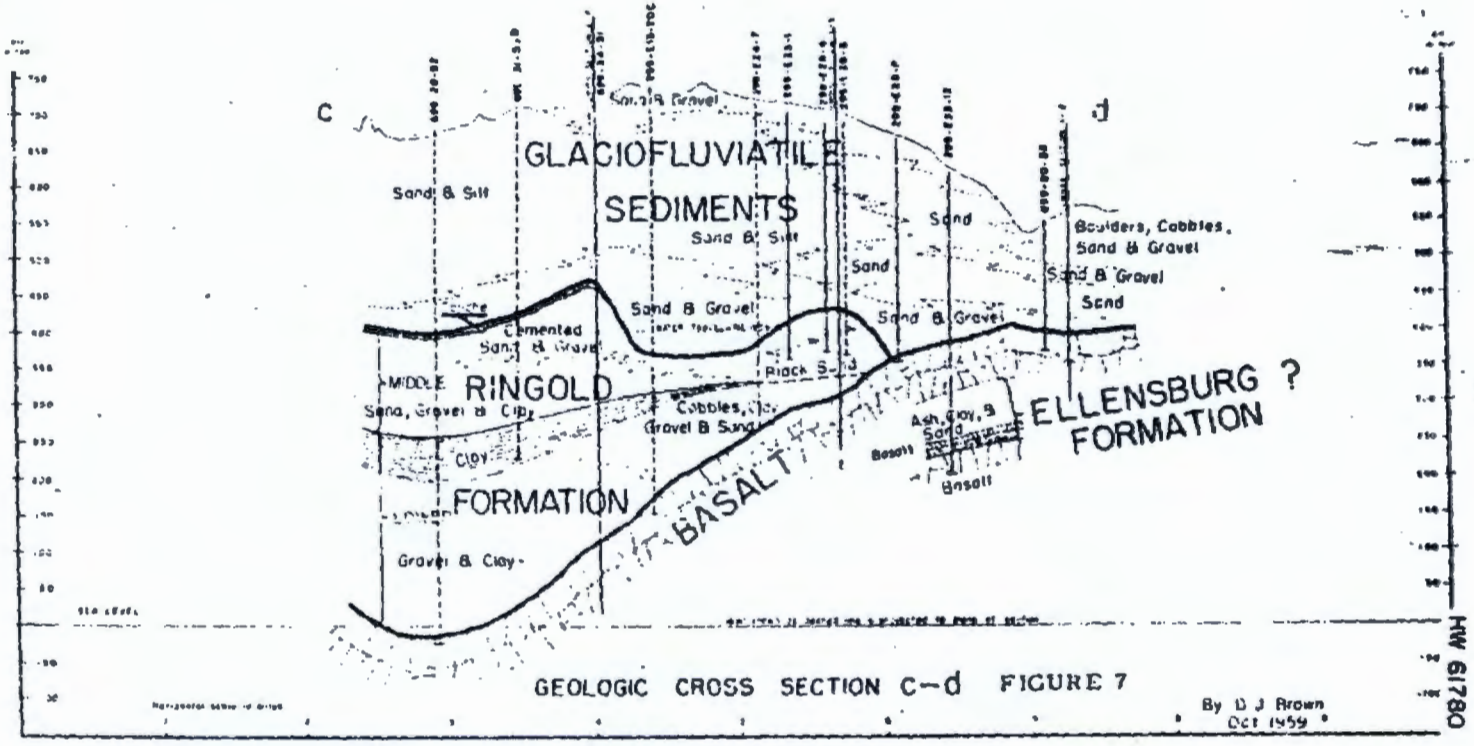

GEOLOGIC CROSS SECTION C–d FIGURE 7

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Oct 1959

impervious, they form the lower boundary of the unconfined ground water. Figures 3 through 7 are geologic sections showing the position of the bedrock beneath the separation areas and its relation to the overlying unconsolidated deposits. The name Columbia River basalt(s) is usually applied to the vast series of lava flows that cover a great part of southern Washington, eastern Oregon, and parts of Idaho, Nevada, and California. Locally some of the flows are included within the Yakima basalts and the Wenas basalts, these representing distinct parts of the Columbia River basalt series in the Yakima area. These lavas came to the ground surface through many fissures in the earth's crust. They were accompanied by the discharge of little or no fragmental material as they welled up to flood the lower ground with successive horizontal sheets. A characteristic of these lavas is their columnar partings, or vertical joints formed during cooling. Recent exploratory drilling at a site several miles from Hanford indicates that the basalt is more than 10,000 feet thick.

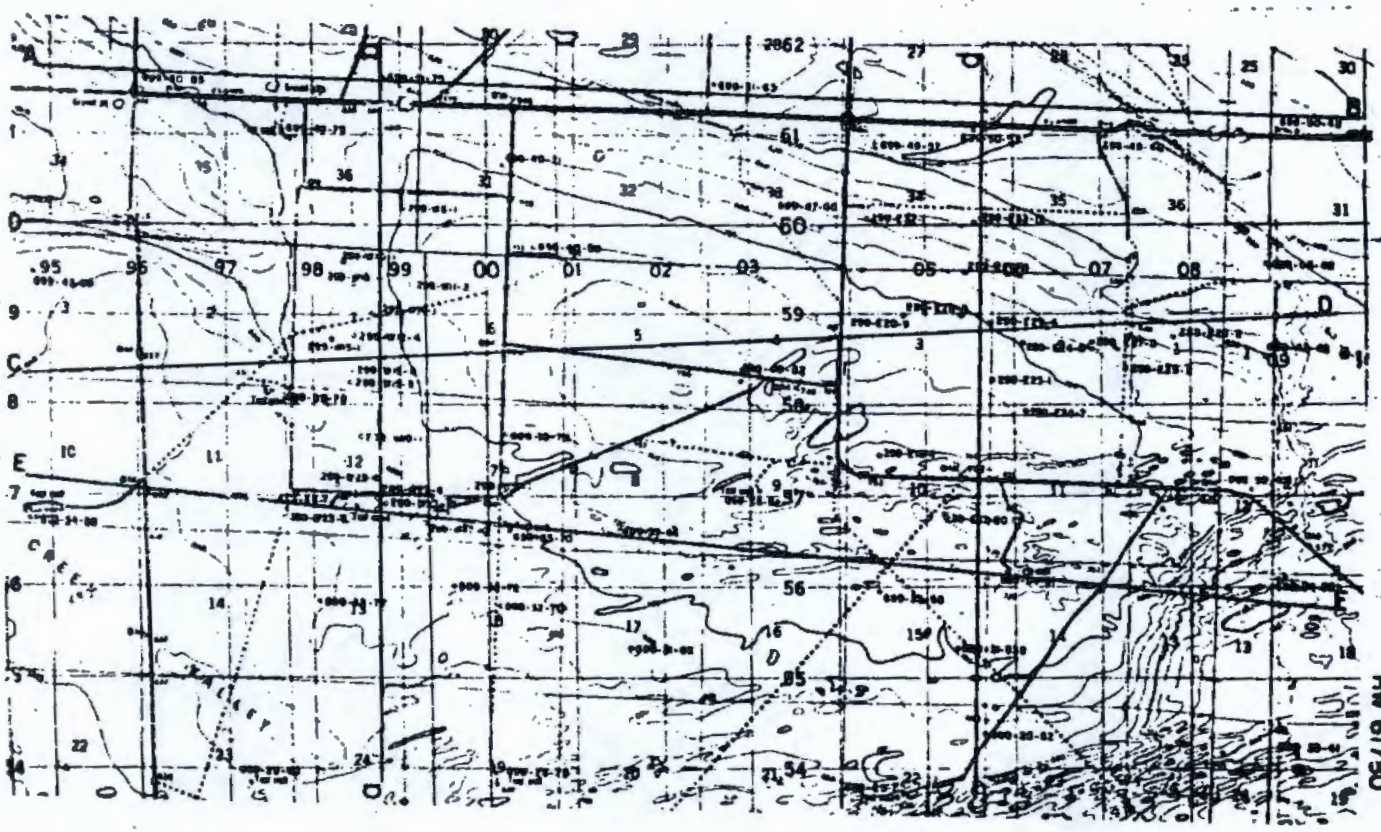
There are 46 wells drilled to bedrock in the expanse studied (Figure 2). Only two of these completely penetrated the uppermost flow, which is approximately 70 feet thick. This upper flow is gray-black in color and generally hard and dense. Well cuttings from the surface of this flow, however, show marked differences. In some wells, the upper three or four feet of the flow were broken and jointed and the cracks filled with sand and gravel. In other wells the first few feet of basalt were weathered to a bluish clay. Some of the well cuttings showed the basalt to have a vesicular surface, characteristically formed by

a concentration of gas bubbles. Cuttings from other wells were compact and hard. Samples obtained from depths more than 10 feet beneath the surface of the topmost flow were strikingly similar in color, texture, and composition in most cases. The surface of the basalt appears to have undergone very little erosion except in the northeastern section of the tract. Figure 8 is a map of the separation areas showing the contours on the surface of the basalt bedrock.

Interbedded with the upper basalt flows are several beds of gravel, sand, and clay intermixed with some volcanic ash. These interbeds are believed to be part of the Ellensburg formation, however, positive correlation to the type Ellensburg beds has not yet been achieved. The relative position of these beds is shown in Figure 7. The Ellensburg formation and the upper portion of the Columbia River basalt are believed to be of Pliocene age (6, 7).

Ringold Formation

Overlying the basalt bedrock is a lacustrine and fluviatile deposit known as the Ringold formation. This formation is composed of silt, sand, gravel and clay with some beds of pyroclastic materials. These sediments were deposited in a shallow lake formed in Pleistocene time (8) when the Columbia River was impounded by the uplift of the Horse Heaven Hills. The materials, which were originally as much as 1200 feet thick, were eroded beneath the separation areas and are now less than 600 feet thick. Figure 9 is a contour map of the present surface of the Ringold formation and shows a section in the northeastern portion of the area where the Ringold formation was completely stripped away from above the basalt.



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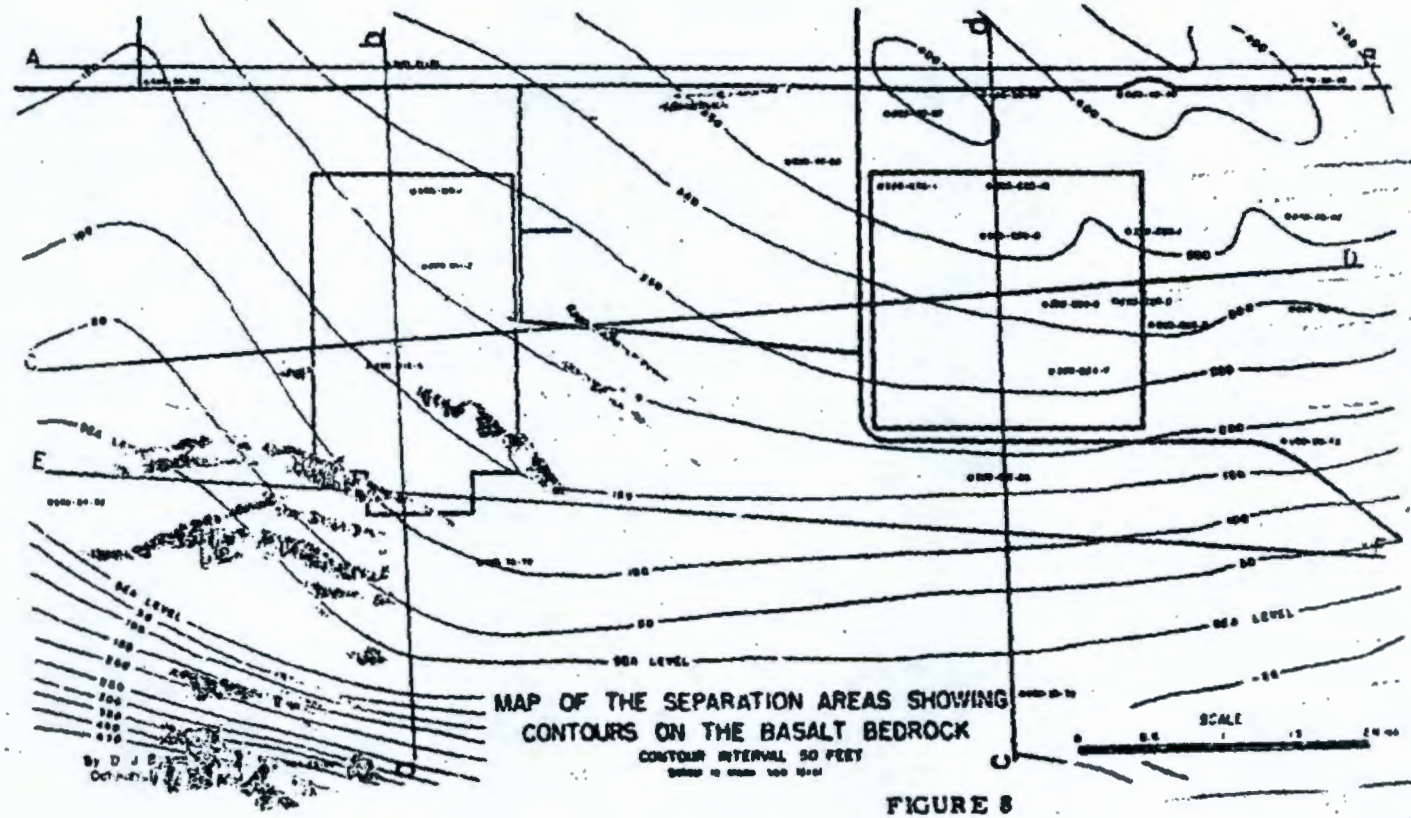


MAP OF THE SEPARATION AREAS SHOWING CONTOURS ON THE BASALT BEDROCK

CONTOUR INTERVAL 50 FEET

FIGURE 8

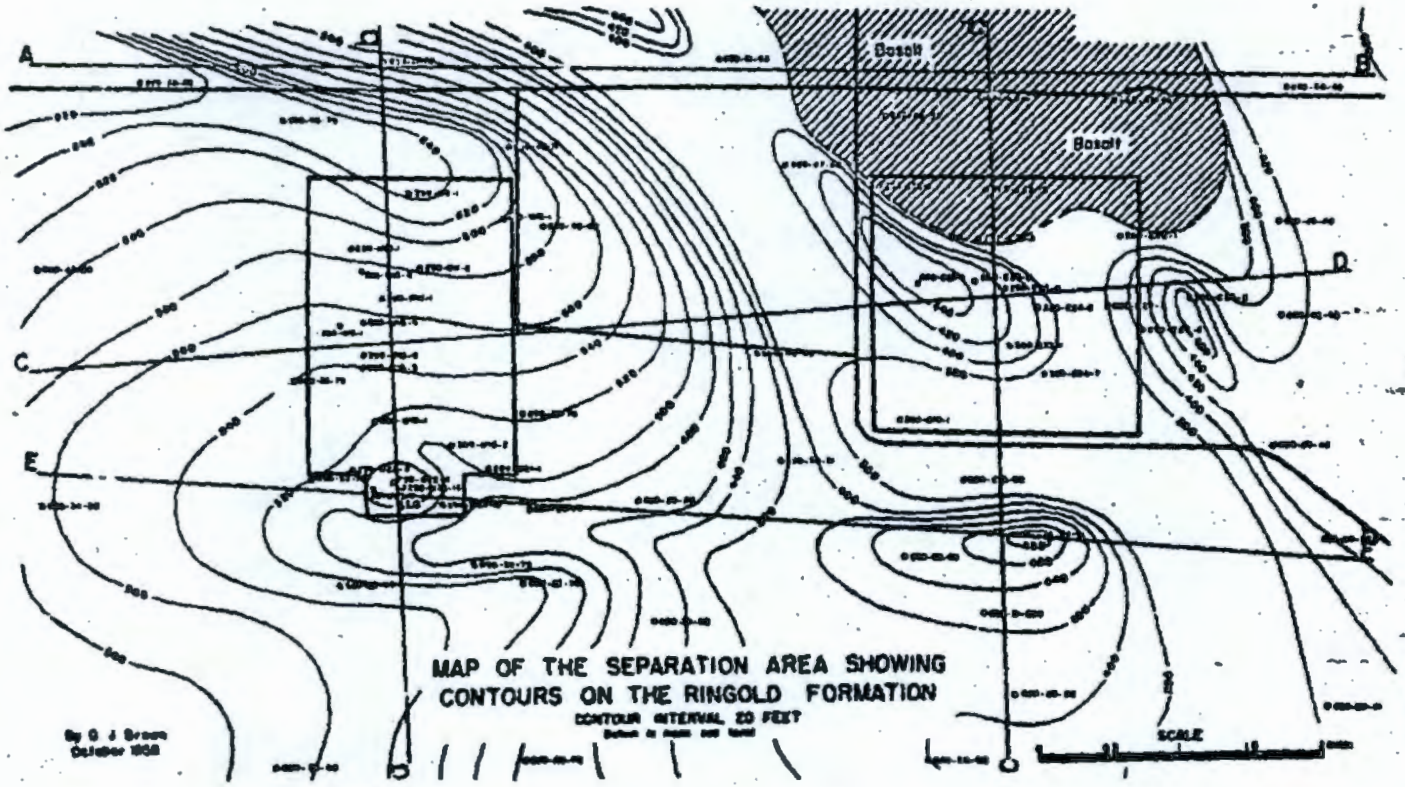
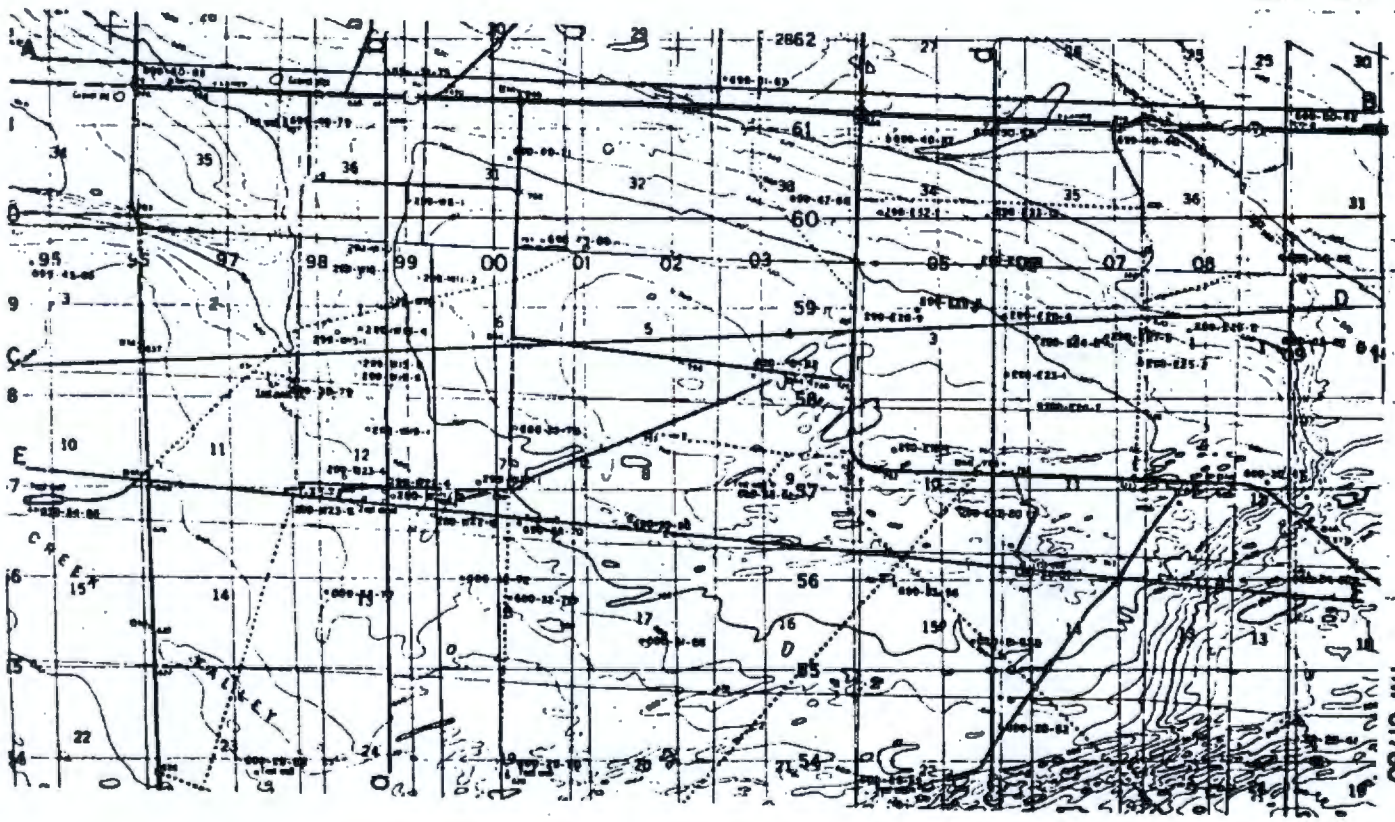

A
B
C
D
E
F
Basalt
Basalt
SCALE
MAP OF THE SEPARATION AREA SHOWING
CONTOURS ON THE RINGOLD FORMATION
CONTOUR INTERVAL 20 FEET

FIGURE 9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A relatively thick accumulation of caliche or calcium carbonate formed on the upper erosional surface of the Ringold formation over much of the region. This caliche horizon is used as one of the criteria to distinguish the Ringold formation from the overlying sediments. In general the materials comprising the Ringold formation are quite similar to those found in the later deposits above it. Where the caliche was eroded away, differentiation between the Ringold sediments and the fluviatile deposits is in places difficult.

The Ringold formation is commonly separated into three lithologic zones. The lower part of the Ringold formation characteristically contains significant quantities of a blue-green clayey silt and is known locally as the "blue-clay" zone. Beneath the separation areas, however, this zone is largely sands, gravels and cobbles, with subordinate clay beds. The middle portion of the Ringold formation consists of locally consolidated and semi-consolidated silts, sands and gravels, and is referred to as the "conglomerate" zone. However, beneath the separation areas most of the materials in this zone are unconsolidated. The upper silt zone of the Ringold formation consists largely of fine materials similar to those of the "blue clay" zone. These materials lie above the water table and have thus undergone extensive oxidation and hence do not possess the blue-green color of the lower zone. The upper portion of the Ringold formation crops out in the bluffs along the eastern side of the Columbia River from near the old townsite of White Bluffs to Richland. Erosional processes have stripped the upper Ringold sediments from all but the extreme western section of the areas (see Figures 3, 4 and 5).

As shown in Figure 9 several knolls of Ringold sediments occur beneath the east-central portion of the territory. These knolls are capped by caliche or cemented gravel or both, and appear to have resulted from the differential erosion of the Ringold formation in that locality. Figure 9 also shows the position of several erosional channels which have been incised by an earlier Columbia River.

Palouse Soil

Locally overlying the Ringold formation in the western part of the separation areas is a bed of fine sand and silt as much as 60 feet thick. This bed is believed to be of eolian origin and is locally called "Palouse soil" because of its similarity in grain-size and heavy mineral composition to the eolian Palouse soil of eastern Washington and western Idaho. The fact that this bed directly overlies the Ringold formation suggests that the materials in the bed and also the materials in the Palouse soil of eastern Washington might be at least in part derived from the Ringold formation, and this was tentatively demonstrated by means of heavy mineral correlations (10).

Glaciofluviatile Sediments

Glaciofluviatile sediments, deposited in recent times by a Columbia River swollen by glacial melt-water, overlie the Ringold formation and Palouse soil. In the separation areas these sediments range from 100 to 300 feet thick. The materials are heterogeneous, ranging in size from very fine clay to very large boulders (see Table I), although lenses of well-sorted materials have been

TABLE I

GRAIN-SIZE DEFINITIONS OF SEDIMENTARY MATERIALS AS USED IN THIS REPORT AND IN COMMON USAGE IN HANFORD GEOLOGIC RESEARCH [4].

Description	(sieve size) mm				in		
Very fine clay	0.00024	to	0.00049		0.0000096	to	0.000019
Fine clay	.00049	to	.00098		.000019	to	.000038
Medium clay	.00098	to	.00195		.000038	to	.000077
Coarse clay	.00195	to	.0039		.000077	to	.00015
Very fine silt	.0039	to	.0078		.00015	to	.00031
Fine silt	.0078	to	.0156		.00031	to	.00062
Medium silt	.0156	to	.0313		.00062	to	.0013
Coarse silt	.0313	to	.0625		.0013	to	.0025
Very fine sand	.0625	to	.125		.0025	to	.0049
Fine sand	.125	to	.25		.0049	to	.0098
Medium sand	.25	to	.50		.0098	to	.0197
Coarse sand	.5	to	1		.0197	to	.0394
Very coarse sand	1	to	2		.0394	to	.079
Very fine gravel	2	to	4		.079	to	.157
Fine gravel	4	to	8		.157	to	.315
Medium gravel	8	to	16		.315	to	.630
Coarse gravel	16	to	32		.630	to	1.26
Very coarse gravel	32	to	64		1.26	to	2.52
Small cobbles	64	to	128		2.52	to	5.04
Large cobbles	128	to	256		5.04	to	10.08
Small boulders	256	to	512		10.08	to	20.16
Medium boulders	512	to	1024		20.16	to	40.31
Large boulders	1024	to	2048		40.31	to	80.63
Very large boulders	2048	to	4096		80.63	to	161.3

noted. The coarse materials are more abundant in the northern and eastern part of the area and grade to finer materials in the west and south. A certain uniform, fine phase of these fluviatile sediments is identified as part of the Touchet formation of southeastern Washington. These materials in the Hanford Works area were deposited mainly in the district south of the region indicated in Figure 2, but interfinger with the coarse materials beneath this region. Some of the glaciofluviatile materials have been slightly reworked by the wind and a thin veneer of windblown sand and silt mantles the southern part of the tract.

STRUCTURE

Tectonic deformation has been significant in forming the geologic and topographic feature of the Pasco Basin. Largely subsequent to the accumulation of the Columbia River basalts, lateral stresses produced a series of essentially east-west trending anticlinal ridges and synclinal troughs in the region (11). The separation areas are located midway between two of these structures, the Umtanum Ridge-Gable Mountain anticline on the north and the Cold Creek syncline to the south (12, 13). The basalt beneath the site has a one to two-degree dip in a southerly direction. This dip is greatly exaggerated in the cross section of Figures 3 through 7 because of the differences in the vertical and horizontal scales.

The Ringold formation has been deformed at least in part with the basalt (14). The lower clay portion shown in Figures 3 through 7 appears to be quite conformable with the surface of the basalt. The middle and upper portions of the Ringold

formation are deformed with the basalt but to a lesser extent. The Palouse soil and glaciofluviatile sediments unconformably overlie the Ringold formation. These deposits may have also undergone some slight deformation since they were laid down.

ACKNOWLEDGMENTS

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