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UNDERGROUND WATER RESOURCES IN THE VICINITY OF OROFINO, IDAHO AND OF LAPWAI, IDAHO

by

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CONTENTS

ILLUSTRATIONS

UNDERGROUND WATER RESOURCES IN THE

VICINITY OF OROFINO, IDAHO.

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INTRODUCTION

PURPOSE AND SCOPE OF THE SURVEY.

The need for an adequate, as well as a pure and uncontaminated water supply for the North Idaho Sanitarium situated at Orofino, Idaho, prompted the superintendent of that institution to apply to the Idaho Bureau of Mines and Geology (which has made numerous underground water supply surveys for various Idaho municipalities and institutions) for geological aid.

A brief investigation lasting for five days in the field was conducted in October, 1926, and June 1927, wherein the geology and underground water conditions of an area comprising about 470 square miles east of the Clearwater River was studied by Virgil R. D. Kirkham, Geologist, Idaho Bureau of Mines and Geology. M. Melville Johnson, a student at the University of Idaho, School of Mines, assisted in the field.

General geologic information secured by the writer on previous brief reconnaissances during the past five years was extremely helpful. The area is shown on Plate 1.

ACKNOWLEDGMENTS

The writer gratefully acknowledges the assistance extended by T. E. Edwards, C. E., of Orofino and Paul Wohlen of Orofino, Supervisor of the Clearwater National Forest, for base maps used in this survey. Appreciation is also expressed to J. H. O'Connor of Weippe, who has drilled many wells in the vicinity of Orofino and Weippe, for making available much statistical data and well logs, some of which are reproduced herein.

The writer is grateful to John Irvine McKelway, M. D., of the North Idaho Sanitarium whose services and information helped the survey.

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3. Kirkham, Virgil R. D. - Ground Water for Municipal Supply at St. Maries, Idaho, - Idaho Bureau of Mines and Geology Pamphlet 17, November, 1926.

4. - Ground Water for Municipal Supply at Potlatch, Idaho Idaho Bureau of Mines and Geology Pamphlet 23, June, 1927.

5. Laney, F. B., Kirkham, Virgil R. D., and Piper, A. M., - Ground Water Supply at Moscow, Idaho - Idaho Bureau of Mines and Geology Pamphlet 8, December, 1923.

6. Lindgren, Waldemar - A Geological Reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho - U. S. Geol. Survey Prof. Paper 27, 1904.

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8. Russell, I. C. - Geology and Water Resources of Nez Perce County, Idaho U. S. Geol. Survey Water-supply Papers 53 and 54, 1901.

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10. Shannon, E. V. - Minerology of Some Black Sands from Idaho with a Description of the Methods Used for their Study - U. S. Nat. Mus. Proc., Vol. 60, Art. 3, pp. 1-33, 1921.

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Some of these publications apply only generally to the area, or describe conditions or formations characteristic of this region. References to them throughout the succeeding pages are made by the serial numbers.

G E O G R A P H Y

LOCATION

The region mapped constitutes about 470 square miles of territory in Clearwater County, Idaho, north of Lolo Creek, east of Clearwater River and southeast of the North Fork of the Clearwater. Orofino lies at the western edge of the area. Meridian 116° 20' lies at the edge and meridian 115° 40' cuts through the eastern tip of the mapped area. The southern part of the area extends to approximately 46° 17' North and the northern part reaches beyond parallel 46° 37'. The area extends from Rs. 1 to 7 E. inclusive and from Tps. 34 to 38 N. inclusive.

TOPOGRAPHY

The entire region lies within the drainage of the Clearwater River. The most important tributaries of which within the mapped area are the North Fork, Lolo, Orofino, Fords, and Canyon creeks. Four types of topography are included in the area: (1) mountainous provinces made up of metamorphosed sediments and granitic igneous intrusions in a mature and relatively rough stage of erosion; (2) plateau-like lava terraces and uplands; (3) deep, youthful canyons in the lava and older rocks; (4) rock terraces, within the canyons, composed of shoulders of the more resistant metamorphosed rocks, or a terrace-like topography produced by vast landslides.[8]

Type No. 1 lies in the eastern part of the area and constitutes part of a deeply dissected westwardly tilted plateau which forms the western outline of the Bitterroot and Clearwater mountains and other ranges of the Rocky System. Type No. 2 occupies the major part of the mapped area. Type No. 3 is represented by the valleys of the Clearwater and its tributaries. Type No. 4 is characteristic of the Clearwater and its north fork.

The area ranges from approximately 1050 to 6100 feet above sea level. The granitic and older rocks form the higher peaks in the regions.

SETTLEMENTS, OCCUPATIONS, AND ACCESSIBILITY

Orofino, the chief center of habitation, has about 1,000 inhabitants. The rest of the area which includes smaller towns such as Pierce, Weippe, Greer, and Asahka, contains perhaps 4,000 additional people. Lumbering, milling, mining, farming and dairying are the chief industries. Heavy timber clothes the mountainous provinces and much timber is found throughout the area. The plateau-like lava terraces yield excellent crops.

The main roads occupy the stream valleys and the region is served by the Northern Pacific Railway which extends up the Clearwater from Arrow Junction. From Orofino a branch line extends up Orofino Creek to Headquarters.

G E O L O G Y

STRATIGRAPHY, PETROLOGY, AND STRUCTURE

The rocks in the region range in age from pre-Cambrian (Algonkian?) to Quaternary and are represented at the surface by highly metamorphosed sediments (possibly Belt series); by stratified gneisses and schists, a transition phase into the granitic intrusion; by quartzites, conglomerates, sandstones, shales, limestones, and old schistose greenstone lavas; by a granitic intrusion of intermediate composition chiefly diorite and granodiorite; by basalt lava flows including interleaved lake beds, silt, and soil, and by hillwash and alluvium.

Belt Series (?) *[3,4,6,7,8,11]

Highly metamorphosed sediments questionably referred to the pre-Cambrian Belt series of Algonkian age though they may be Animikean or Archean, are exposed in the canyon of Clearwater River from two miles above Orofino to Asahka. East of Asahka they are exposed in the North Fork Canyon to beyond Dent. East of Orofino they are exposed in the canyons of Whiskey and Orofino Creeks.

These rocks, at every place where they were observed, were stratified gneisses, mica and garnet bearing schists and crystallized magnesian limestones and dolomites, all showing well marked bedding planes. These rocks have a general strike from N. 7° E. to N. 11° E. and a characteristic dip of 68° to 84° east.

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* Calkins, F. C. and MacDonald, D. F. - A Geological Reconnaissance in Northern Idaho and Northwestern Montana-U.S. Geol. Survey Bull 384, 1909
Kirkham, Virgil R. D., and Ellis, Ernest W. - Geology and Ore Deposits of Boundary County, Idaho-Ida. Bur. of Mines & Geo. Bull 10, Nov., 1926
Ransome, F. L., and Calkins F. C.-The Geology and Ore Deposits of the Coeur d'Alene District, Idaho - U. S. Geo. Survey Prof Paper 62, 1908
Umpleby, J. B., and Jones, E. L. Jr.-Geology and Ore Deposits of Shoshone County, Idaho - U. S. Geol. Survey Bull. 732, 1923.

The more highly metamorphosed areas always occur near the exposed granitic intrusions, and undoubtedly this series is of sedimentary origin. Although, no fossils have been found within this series but because of their grographic position in relation to areas determined as Beltian rocks by stratigraphic and lithologic similarities, they are believed to be either an extension of the Belt series, or a possible overlying Cambrian formation. The intense metamorphism of these roof rocks of the granitic intrusion prohibits their positive classification as Belt rocks on purely lithologic grounds.

Snake River Series (?) Permian (?)

A series[6,7,8] consisting of quartzite, conglomerate, shale, sandstone, impure limestone, and highly altered schistose andesitic lavas and greenstone schist is exposed in the Clearwater River canyon near Asahka. This series appears on lithologic grounds to be an extension of the Permian rocks exposed in the Snake* and Salmon river canyons farther west and south. Where exposed, they strike 4° to 8° West of North and dip about 85° to the east. Their relationship to the pre-Cambrian (?) series is not clear.

Granitic Igneous Intrusions, Cretaceous (?)

The Mascot Hills, or Clearwater Mountains as they are commonly called, and the canyon walls of the North Fork, Orofino, and Lolo Creeks and of the Clearwater near Greer are made up of intruded cupola-like masses of granodiorite and diorite which have been uncovered by erosion during Tertiary and Quaternary time.

This magmatic intrusion which is part of the well known Idaho batholith probably occurred in either Jurassic, Cretaceous, or Eocene time. Its phases range from granodiorite, quartz-monzonite and diorite to granite and they are assumed to be differentiations from a common magma possibly dioritic in composition.

In the field, the rock shows a uniform light grey and pink color with large phenocrysts of orthoclase feldspar. An aureole of gneissic and schistose material several thousand feet thick is commonly found as a transition phase in this region.[11] Contact metamorphism is apparently greater at the roof than at the sides, on account of the presence there of more magmatic gases and altering agents. This formation is represented on the map by oblique lines and is undifferentiated from the Mesozoic and pre-Cambrian formations.

Basalt Lava Flows. Miocene.

Lava flows of an age assigned generally to the Miocene and thought to represent one of the more easterly embayments of the vast Columbia River Lava plateau to the westward, constitute the most important rocks affecting the underground water supply of the area.

This material, at one time molten viscous lava, was poured out in great quantities over the old land surfaces. The upper surface of the flow formed a comparatively level valley floor. Considerable time intervals elapsed before the second and ensuing flows as evidenced by the accumulation of soils,

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* Livingston, D. C. and Laney, F. B. - The Copper Deposits of the Seven Devils and adjacent Districts. Idaho Bur. of Mines & Geol. Bull 1, 1920.

silts, and lake-bed materials. The second flow was poured out on a relatively level surface and its upper surface presented another flat valley floor at a higher level. This was repeated until at least seventeen flows covered parts of the area. The later flows, overlapped the foothills.

A fairly high relief with rugged contours had been established in the Belt (?) sediments and granitic intrusions previous to the outpouring of the lava, and these valley flows were, therefore, confined to old established drainage depressions of considerable width. The later flows being successively at higher elevations overflowed the true valleys and abutted upon the flanks of the foothills.

This inundation of the older rocks by the Miocene (?) basalt permitted the higher outlying peaks to remain as uncovered islands in this "lava sea" in many places.

The basalt of the area is a heavy, dark, hard rock, differing greatly in texture and characteristics in the various flows. At some places it shows the characteristic "dice rock" and "pillar rock" structure while at others it is vesicular and porous. Although nearly horizontal, the flows dip gently to the west at every place observed. Determination of the attitude and number of the flows is greatly handicapped in the canyon walls by the presence there of great masses of landslide material which duplicate the flows and tip the basalt in all directions.

Erosion had dissected the originally level surface of the basalt until now it is exposed as wide terraces and mesas between the larger streams which have cut through the flows, into the underlying rocks. Consequently no extensive areas of uncut lava flows remain in the region. In the regions to the east where the streams have as yet failed to cut through the basalt, well logs show that it is relatively thin and represents not more than three flows.

Interbedded with the basalt flows in this area a formation occurs which is commonly found associated with the basalt along the eastern and southeastern edges of the Columbia River lava plateau. It has been called the Latah formation, at Spokane, by Pardee and Bryan* of the United States Geological Survey. It has also been described at St. Maries,[3] Moscow,[5] and Potlatch.[4]

Although much of the observed formation was in landslides, it is believed that two horizons of Latah exist in this area; both of these layers are between lava flows, a relationship which is characteristic wherever the Latah has been found in Idaho.

The formation in the Orofino area is brown sandstone, white shale, volcanic ash, and carbonaceous seams. The top layer appears to be about 150 feet thick, capped by 200 feet of lava. The second layer is about 250 feet thick and is separated from the top layer by at least 500 feet of basalt. Typical leaf fossils of the Latah were found in these beds.

Although some of the members might act as aquifers, the chief value of the Latah in connection with underground water is its imperviousness. A perched water table should lie on the top of each of these clay and shale beds.

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* Pardee, J. T., and Bryan, Kirk - Geology of the Latah Formation in Relation to the Lavas of the Columbia Plateau near Spokane, Washington - U. S. Geol. Survey Prof. Paper 140A, January, 1926.

The total thickness of Latah is probably 450 feet. A loessal or wind-carried overburden, generally called the "Palouse Hills," "Palouse formation," and "Palouse soil" is found, in varying depths, covering the lava in much of the area. This material, whose exact origin is now in debate, probably had many sources. In many places to the west it has a thickness and character which perhaps justifies the adoption of a true formation name. It is included under the basalt symbol here.

Considerable Pleistocene and Recent river gravels, hillwash, and alluvium lie in some of the stream valleys. They are not differentiated from the pre-lava rocks because they are not material to this report.

SOME CONSIDERATIONS OF UNDERGROUND WATER AND THE FACTORS AND ESSENTIALS FOR ITS OCCURRENCE WITH AN EXPLANATION FOR THE LAYMAN OF SOME TECHNICAL TERMS.

Although much water for potable and industrial purposes in supplying cities, towns, factories, farms, and irrigation projects comes from underground, it originated from some form of precipitation such as snowfall or rainfall on the earth's surface. The melting snow or rain is eliminated by three processes, namely: evaporation, surface run-off in streams, and seepage into the ground. The water underground is generally conveniently divided into two heads to avoid confusion - these are ground water and artesian water.

GROUND WATER

Although some of the water which is constantly seeping into the ground is retained in the upper soil by capillarity and speedily returned to the surface again by evaporation, most of it sinks deeper into the lower soil and underlying rock masses which it saturates to a certain level. This zone of saturation comprises a great body of water which furnishes water for lakes, springs, and streams, and is the water encountered by shallow surface wells. Its upper surface, which is the level maintained in a shallow well, fluctuates with the seasons and the rainfall and snowfall of the area, but actually underlies the land surface at a relatively short distance at all times. When the land surface is irregular so, also, is this upper surface or water-table, but to a lesser degree. Thus the water-table is farther from the surface beneath the hills and closer to the surface beneath the valleys. In many depressions it comes to the surface as temporary springs, as swamps, as lakes, or as seeps which insure the level of permanent streams. In regions with heavy rainfall, this water-table is close to the surface, and in arid regions, it may be several hundred feet below the surface. Its distance from the surface in any region, of course, fluctuates with and lags behind the wet and dry seasons. The movement of this water is, as at the surface, in a down-hill direction and it generally comes to the surface, or is concentrated in valleys and follows the valley bottom where it may be in some cases entirely separated from an overlying river by an impervious clay layer. It is the most common source of underground water.*

ARTESIAN WATER

The various bed-rock types, underlying the surficial layers of soil and unconsolidated materials, have varying degrees of porosity and thus different capacities for holding water. The water collects in cavities such as pores

*In the discussion which follows, the possibility of waters derived from other than surface sources, such, for example, as certain hot springs, is purposely omitted.

between grains or crystals, joint cracks, bedding planes and vesicles, and saturates the rock to the best of its ability. Many rocks are relatively impermeable to water and others are porous and can hold or conduct a large amount of it.

When a particularly porous rock is overlain by a relatively impermeable layer, little water will enter it by downward seepage and it may not reach saturation. If, however, this porous rock is folded or tilted so as to be eroded and outcrop at the surface, it may readily become filled with a greater supply than the overlying formation.

True artesian water is that confined in rocks under sufficient hydrostatic pressure to cause the water, when a way of escape is afforded, to rise towards the surface although not necessarily high enough to flow out at the surface. The essential difference then, between artesian water and ground water, is the tendency of the former to flow toward the surface as a result of confinement and pressure, whereas the latter sinks away from the surface. The ideal requisite factors for artesian conditions may be stated as comprising: (1) an adequate source of water supply, such as heavy rainfall or snowfall, (2) a porous layer or rock area, known as an aquifer, well enough equipped with cavities to contain a large supply of water, (3) a practically impermeable retaining agent which resists the upward progress of the water, (4) and a source of pressure. Many conditions exist in rock masses where a variety of water traps are created which possess those four factors. The common one, however, is where stratified beds of varying degrees of permeability have been warped from their original horizontal, or nearly horizontal, depositional position to a tilted or folded position so as to provide an artesian slope or basin wherein the permeable beds, or aquifers, are exposed at the surface and fed therefrom and lie between impermeable or slightly permeable beds. The entering surface water, under these most favorable conditions, flows down hill along these porous beds until it escapes at a lower level or, failing escape, backs up the slope as the pervious bed is filled, thus developing an increasing degree of saturation until no more can be held. In an artesian slope, an increasing pressure is exerted in a saturated bed from the outcrop to the lowest position on the slope. Should there be a natural outlet at this lowest point, the pressure is relieved. Although artesian conditions may still prevail up the slope, because of the friction and slowness of movement and the size of the reservoir area, flowing surface wells may not be expected because of the lack of pressure and true confinement. In an ideal artesian basin, water at the low point in the aquifer receives a hydrostatic pressure from the slopes in every direction and when tapped will flow at the surface, providing it is considerably lower in altitude than most points of outcrop of the aquifer.

DEFINITIONS*

Annual ground water increment. - The increment or recharge of ground water may be approximated by a simple calculation. From the annual precipitation of the area is subtracted the stream run-off as measured by stream guages, and from this remainder is subtracted the loss by evaporation and vegetal usage, which usually must be approximated. The final remainder enters the ground in the catchment and intake areas and represents so many inches, or fractions thereof, which are converted then into acre-feet by multiplying by the size of the catchment area, thus making it possible to determine the amount of water than can be extracted from an artesian basin without impairing its producing possibilities.

*For a more adequate discussion of this subject, the reader is referred to Meinzer, Oscar E. - Outline of Ground Water Hydrology - U. S. Geol. Survey Water-Supply Paper 494, 1923.

<u>Aquifer</u>. - Any permeable, porous formation, (layer, rock, or substance) which will permit water under ordinary pressure to move perceptibly through it.

<u>Confining Bed</u>. - Any impermeable or impervious formation (layer, rock, or substance) which will not permit movement of ground water under ordinary pressure.

<u>Intake Area</u>. - The intake area is the actual surface dimension occupied by the outcrop of the aquifer. It usually slopes away from the flanks of an elevated area where exposed by erosion or by unconformity. The outcrop may occupy a narrow belt or an irregular area and dip into the basin where it is covered by the confining bed. The size of the intake area varies with its nature, thickness and inclination, as well as the topography of the region. In a relatively flat region, a gently tilted aquifer of great thickness would have an enormous intake area. In a similar region, a vertically tilted aquifer of the same thickness would have a very small intake area.

<u>Catchment Area</u>. - Most of the water which enters an aquifer through its intake area is water which fell elsewhere and drained to it rather than that which falls immediately thereon. That area whose drainage crosses an intake area is called the catchment area and always includes the intake area. Elevated regions near intake areas are generally catchment areas and the surface stream-drainage divide becomes also the catchment divide.

<u>Static Level</u>. - The level at which water stands in an artesian well at any one point in an aquifer. It may be higher or lower at different wells at some distance apart in the same aquifer. It is similar to the surface water-table but independent of it.

<u>Piezometric Surface</u>. - An imaginary surface that everywhere coincides with the static level of the water in an aquifer.

<u>Isopiestic Line</u>. - This is a line on the piezometric surface whose every point is an equal distance above sea-level. It is a contour line.

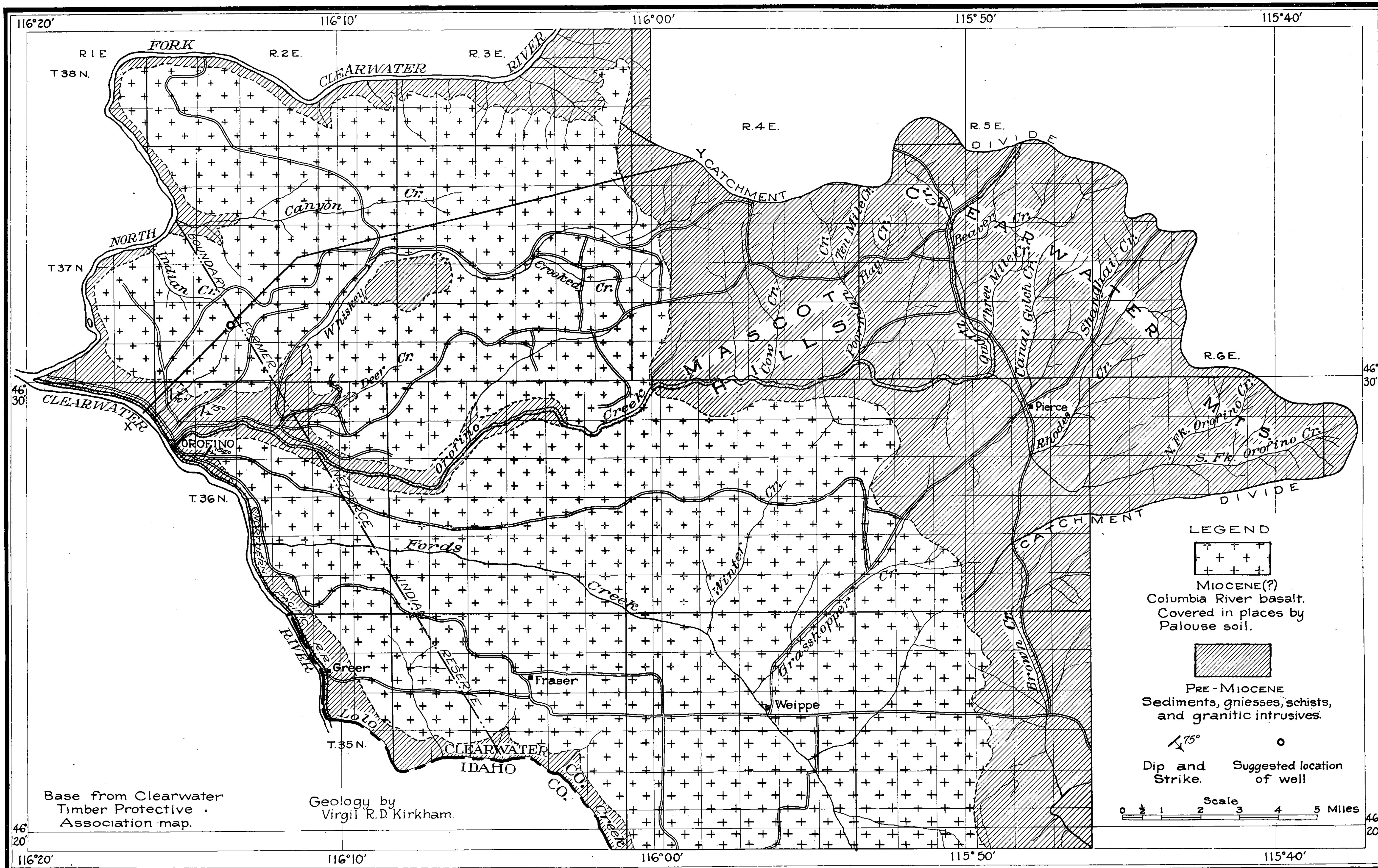
<u>Hydraulic Gradient</u>. - This is the vertical drop or rise per unit of length of the piezometric surface of an aquifer. It is a measure of the pressure drop as the water moves through the aquifer. The speed of underground flow is proportional to the steepness of this gradient. Artesian water flows from a few hundred feet to a few hundred yards per year.

THE UNDERGROUND WATER SUPPLY OF THE REGION EAST OF OROFINO.

The average annual precipitation of the mapped area is approximately 38 inches. At Orofino on the extreme western edge of the area the annual precipitation is but 24.1. This station, however, lies in a canyon two thousand feet lower than the main area.

It has been estimated that 27 inches of this precipitation escapes as stream run-off and that 9 inches is used in evaporation and vegetal discharge. This leaves 2 inches which enters the catchment area and constitutes the annual groundwater increment.

The area within the catchment divide lying east of Orofino has a total estimated catchment area of 77,000 acres. This figure, when reduced, yields



GEOLOGIC SKETCH MAP OF THE REGION EAST OF OROFINO, IDAHO.

approximately 12,800 acre-feet of water. This result, computed in cubic feet of water and in millions of gallons of water increment, annually yields an amount so far in excess of the possible demand as to permit the annual increment factor to be disregarded in connection with this project.

The North Idaho Sanitarium requires a supply which will provide potable water for 350 people. 40 gallons per minute will easily satisfy this demand and a yield of 150 gallons per minute would satisfy the demand of the Sanitarium and also the town of Orofino. A ground water increment of only 400 acre-feet of water would be sufficient to supply this need.

The basalt area is actually a very imperfect reservoir because it is in a constant state of drainage from spring outlets in the canyon wells. The annual increment accordingly is theoretically never cumulative because of lack of proper confining agencies. Actually, however, the uneven terrane of the older rocks may in some places constitute a sub-basalt barrier which might dam the flow, and the prevalence of landslide material in canyons undoubtedly dams the leakage in many places. Regardless of the number of wells used, it would be a practical impossibility to recover any large portion of the annual increment because of seepages impossible to stop and because of mechanical difficulties in extraction. The requirement of 400 acre-feet as contrasted with 12,800 acre-feet annual increment makes sure, however, than even this imperfect reservoir will yield an ample supply.

Basalt flows usually make excellent aquifers inasmuch as the fine-grained part of each flow often acts as the impermeable layer, and a lower vesicular, porous jointed, and broken zone is often an excellent aquifer. Where more than one flow exists another impermeable zone also exists and so on. There is usually a layer of soil or sediment between flows which also acts as a passageway for the water.

The intake area occurs where the basalt abuts against the rocks of the Belt series. It is relatively narrow, and, in this instance, is on the underside and edges of the flows rather than exposed at the surface. The upper surface of the flat-lying basalt, where exposed, acts also as an inefficient intake area since it permits some water to descend into underlying aquifers by means of the columnar joints perpendicular to them. These are located in the fine-grained and supposedly impermeable zones between the more porous zones or layers.

Although the basalt layers can deter the upward rise of water, this fact is of little consequence here because the aquifers are drained naturally into the vast canyons to the west. The accumulation of pressure is prevented because there is no barrier in the old pre-basalt valley. The distance from the intake area to Orofino is long enough, however, to permit the building up of a hydrostatic head through friction. Consequently a well tapping these aquifers may be expected to yield as much as 150 gallons of water per minute with the water rising above the aquifer in the well.

STATISTICAL DATA CONCERNING WELLS

Nearly all the wells on the lava plateau east of Orofino have been surface wells which failed to penetrate any of the underlying aquifers. The larger number of the deeper drilled wells are situated in the vicinity of Weippe. The following well logs were secured orally from J. H. O'Connor, well driller of Weippe, Idaho, who drilled all of them, except three which were drilled by A. H. McGuire of Weippe, Idaho, who also furnished logs for wells drilled by him.

Well No. 1.

Owner:	Bert Haywood.
Location:	Weippe.
Depth:	82 feet.
Water level:	50 feet from surface
Casing:	5 5/8 inches to rock
Pump:	Meyers
Production:	13 gallons per minute; estimated possible production 65 gallons per minute.
Log:	12 feet soil.
	50 " basalt.
	20 " sand.

Well No. 2.

Owner:	Community well.
Location:	Weippe.
Depth:	47 feet.
Water level:	39 feet from surface.
Casing:	5 5/8 inches, 12 feet.
Pump:	None installed.
Production:	8 gallons per minute; estimated possible production 40 gallons per minute.
Log:	7 feet soil.
	25 " basalt.
	3 " cavity.
	12 " charcoal and black carbonaceous clay.

Well No. 3.

Owner:	Federal Match Company.
Location:	Weippe.
Depth:	89 feet.
Water level:	70 feet from surface.
Casing:	5 5/8 inches to rock.
Pump:	Meyers.
Production:	15 gallons per minute; estimated possible production 75 gallons per minute.
Log:	11 feet soil.
	72 " basalt.
	4 " cedar logs.
	2 " white sand.

Well No. 4.

Owner:	Hamilton Hotel.
Location:	Weippe.
Depth:	62 feet.
Water level:	50 feet from surface.
Casing:	5 5/8 inches to rock.
Pump:	Meyers.
Production:	13 gallons per minute; estimated possible production 65 gallons per minute.
Log:	8 feet soil.
	51 feet basalt.
	3 feet charcoal.

Well No. 5.

Owner:	Chris Brady.
Location:	Weippe.
Depth:	41 feet.
Water level:	31 feet from surface.
Casing:	4 inches to rock.
Pump:	______________
Production:	15 gallons per minute.
Log:	6 feet soil.
	32 " basalt.
	10 inches charcoal.
	2 feet vesicular basalt.

Well No. 6.

Owner:	Luther and Herman Bonnar.
Location:	Weippe.
Depth:	85 feet.
Water level:	40 feet from surface.
Casing:	5-5/8 inches to rock.
Pump:	____________________
Production:	200 plus gallons per minute.
Log:	9 feet soil.
	41 " basalt
	8 " green clay.
	25 " basalt.
	2 " vesicular basalt.

Two flows of basalt with two aquifers were found in this depth.

Well No. 7.

Owner:	Simon Phleu.
Location:	Weippe.
Depth:	92 feet.
Water level:	___________
Casing:	___________
Pump:	___________
Production:	___________
Log:	87 feet basalt
	2 " clay.
	1 " basalt.
	2 " soapstone (clay).

Well No. 8.

Owner:	A. G. Ward (originally Albert Snyder).
Location:	3.7 miles due west of Weippe.
Depth:	125 feet.
Water level:	___________
Casing:	___________
Pump:	___________
Production:	18 gallons per minute; estimated possible production 100 gallons per minute.
Log:	90 feet soil.
	35 " basalt.

Well No. 9.

Owner:	Milton Cockerell.
Location:	3.8 miles due west of Weippe.
Depth:	105 feet.
Water level:	30 feet from surface.
Casing:	________________
Pump:	________________
Production:	100 plus gallons per minute.
Log:	75 feet basalt.
	30 " soft shales.

Well No. 10.

Owner:	Warren Harrison.
Location:	3 miles due west of Weippe - then 1 mile south.
Depth:	160 feet.
Water level:	________________
Casing:	________________
Pump:	________________
Production:	________________
Log:	100 feet soil.
	55 " basalt
	5 " charcoal.

Well No. 11.

Owner:	Mr. Potfors.
Location:	3 miles west of Weippe - then 3 miles south - then 1/4 mile west.
Depth:	256 feet.
Production:	5 gallons per minute.
Log:	Last 15 feet in granite. Drilled by A. H. McGuire.

Well No. 12.

Owner:	Billy Simmons.
Location:	1/2 mile north of Weippe.
Depth:	119 feet.
Log:	Bottom of this well in stratified lake beds (Probably Latah formation). Drilled by A. H. McGuire.

Well No. 13.

Owner:	Bob Hamilton.
Location:	1/2 mile east of Weippe.
Depth:	115 feet.
Log:	Last 15 feet in granite. Drilled by A. H. McGuire.

Well No. 14.

Owner:	Bert Rideout.
Location:	6.6 miles west of Weippe on highway.
Depth:	266 feet.
Production:	No water.
Log:	20 feet soil.
	16 " brown shale.
	230 " variegated clays, shales, and ash.

If the logs of these 14 wells are authentic a considerable disparity in stratigraphy and sub-lava topography is revealed in a distance of 7 miles east and west and 4 miles north and south. Wells Nos. 1, 2, 3, 4, 8, 9, and 10 show one flow of basalt. Wells Nos. 5, 6, and 7 show at least two basalt flows. Wells Nos. 1, 2, 3, 6, 7, 9, 12, and 14 show sediments, some of which are undoubtedly referable to the Latah formation. Five wells struck charcoal and two penetrated granite at depths of 100 and 251 feet respectively. Well No. 14 is believed to be in Latah formation and if drilled through the underlying basalt would very likely have yielded a water supply.

It can be readily seen that several of these wells yield excellent flows of water from relatively shallow depths. In all cases where information regarding the height of water in the well was obtained, it stood several feet higher than the aquifer. This, of course, shows a hydrostatic pressure developed by hidden barriers or by friction in the aquifer beyond the well. For most of these wells the distance from the intake area is about 5 miles; for a few wells it is more and for some wells it is less.

C O N C L U S I O N

After a study of the geology and the logs of the foregoing wells, the writer concludes that an ample supply of potable water for the North Idaho Sanitarium, and also for the city of Orofino, can be produced by drilling upon the lava plateau east of Orofino.

The main problem is the placing of the well. The lava plateau is so dissected as to isolate certain sections from others. The choice logically falls on that section nearest to the sanitarium because of the cost of piping the water from its source to its place of use in the Clearwater canyon. A study of the area shows that a well drilled on the plateau about three or four miles north and east of the sanitarium would be ideally situated to take advantage of the lava reservoir.

Locations convenient to transportation in the SE 1/4 of Sec. 29, T. 37 N., R. 2 E., would be so situated that a pipe line could follow a gravity course down Rock Creek to the sanitarium. The difference of elevation between the well and the sanitarium would be about 1,900 feet and the pipe line distance would be under 3-1/2 miles. A location at the head of the creek near Dresser's mill pond near the road appears suitable.

The writer strongly urges the necessity of an underground water supply for the sanitarium, or, for that matter, for any institution or municipality where an adequate one is available. He believes that a deep well drilled on the lava plateau suggested, and equipped with perforated casing, so as to be fed by the several aquifers, would produce the desired supply of water. A sufficient quantity of water may be had in a few hundred feet. In no case need drilling be more than 1,000 feet in depth.

The writer suggests that should the North Idaho Sanitarium decide upon a deep well, a driller be secured who will guarantee the desired amount of water for a stated price.

GEOLOGIC STRUCTURE SECTIONS IN THE OROFINO AND LAPWAI AREAS.

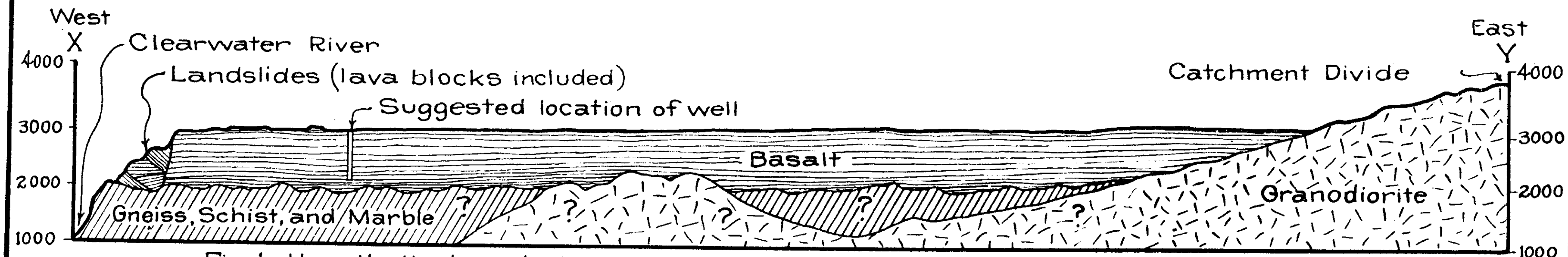


Fig. 1 - Hypothetical geologic structure section along line X-Y on Plate I.

Scale
1 ½ 0 1 2 3 4 Miles

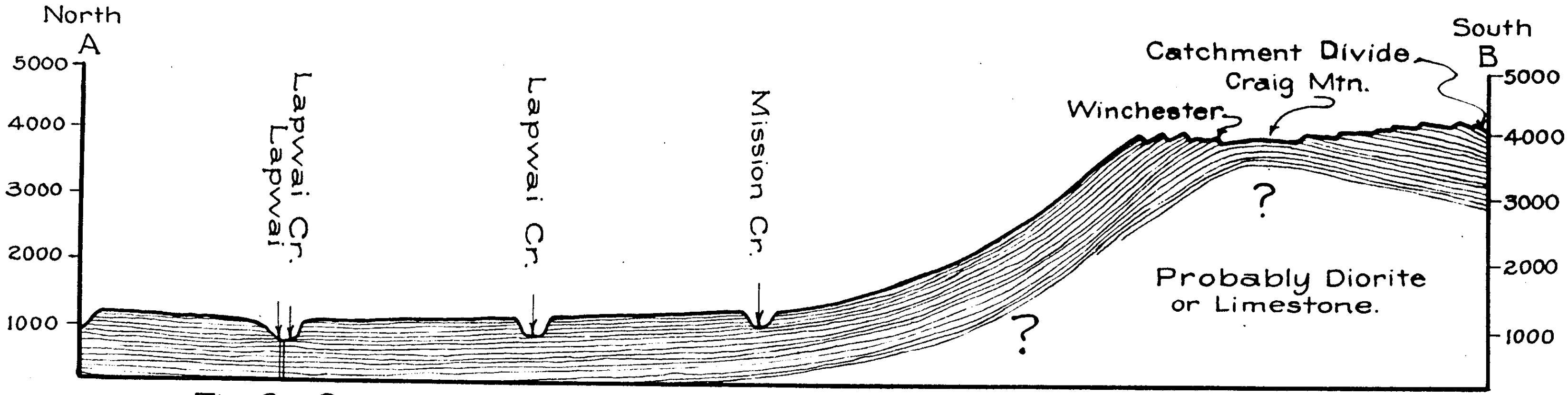


Fig. 2 - Geologic structure section along line A-B on Plate II.

Scale
1 ½ 0 1 2 3 4 Miles

UNDERGROUND WATER SUPPLY IN THE VICINITY OF LAPWAI, IDAHO

by

Virgil R. D. Kirkham

INTRODUCTION

Inasmuch as the government Indian School at Fort Lapwai is forced to repair and enlarge its present water-supply system at considerable expense, the superintendent of that institution has asked whether an adequate and satisfactory underground supply is available. Consequently, the appeal was made to the Idaho Bureau of Mines and Geology (which has made numerous underground water supply surveys for Idaho institutions and municipalities) for geological aid.

This investigation was conducted in conjunction with the Orofino survey and two days were spent in the area at this time. During a previous examination, when an underground water survey was made for Lewiston, Idaho, about five days were spent in the area. The information gained at that time was extremely useful and the time on this examination chiefly was spent in gaining detailed information near Lapwai.

The investigation was conducted by Virgil R. D. Kirkham, Geologist, Idaho Bureau of Mines and Geology, and his assistant M. Melville Johnson. The geology and underground water conditions of a drainage area of 405 square miles surrounding Lapwai was studied during both investigations. This is shown on Plate II.

ACKNOWLEDGMENTS

The writer gratefully acknowledges information provided by George King of Lapwai.

BIBLIOGRAPHY

The previous geologic literature touching on this region or pertinent to this report is the same as that presented in the Orofino report. (See Bibliography on pages 1 and 2.) References to the items found there are made in the succeeding pages by the serial numbers.

GEOGRAPHY

LOCATION

The mapped region constitutes about 317 square miles of territory lying in Nez Perce County, and about 92 square miles situated in Lewis County. It lies south of Clearwater River and northwest of Craig Mountain, Melrose, Reubens, and Craig Junction lie on the eastern edge of the area. Lapwai lies in the northwest edge of the mapped region.

The southern part of the mapped region extends to approximately 46° 10' North and the northern part extends beyond parallel 46° 30'. Laterally the area lies between meridians 116° 30' and 116° 50' W. It reaches from Tps. 32 to 37 N., inclusive and from Rs. 1 to 4 W., inclusive.

TOPOGRAPHY[8]

The entire region lies within the drainage area of the Clearwater River. The most important tributaries within the mapped area are Lapwai, Cottonwood, and Jacks creeks. One type of topography constitutes the entire area. It is commonly known as the Lewiston plateau.

The whole region is made up of a dissected dip slope of the tilted Columbia River basalt. Erosion has occasionally bared small exposures of older rock. The tilted lava comprises the northwestern limb of a vast anticline in the Columbia River basalt which is known as Craig Mountain. The axis of this anticline roughly approximates the catchment divide but actually strikes N. 45° E. and lies between Winchester and Craig Junction. This sloping plateau-like surface rises to heights in excess of 4,500 feet above sea level, and the country in the Clearwater Canyon is less than 800 feet above sea level.

Mission and Lapwai creeks rise on the southeast side of the anticlinal axis and cut across the anticline to form deep canyons in the dip slope of the plateau surface.

SETTLEMENTS, OCCUPATIONS, AND ACCESSIBILITY

Lapwai has a population of about 500 people, exclusive of the Indian School of about 200 students. Winchester and Culdesac also have about 500 inhabitants each. Gifford has about 150 inhabitants and the other settlements have fewer numbers. The total population of the mapped area is less that 4,000.

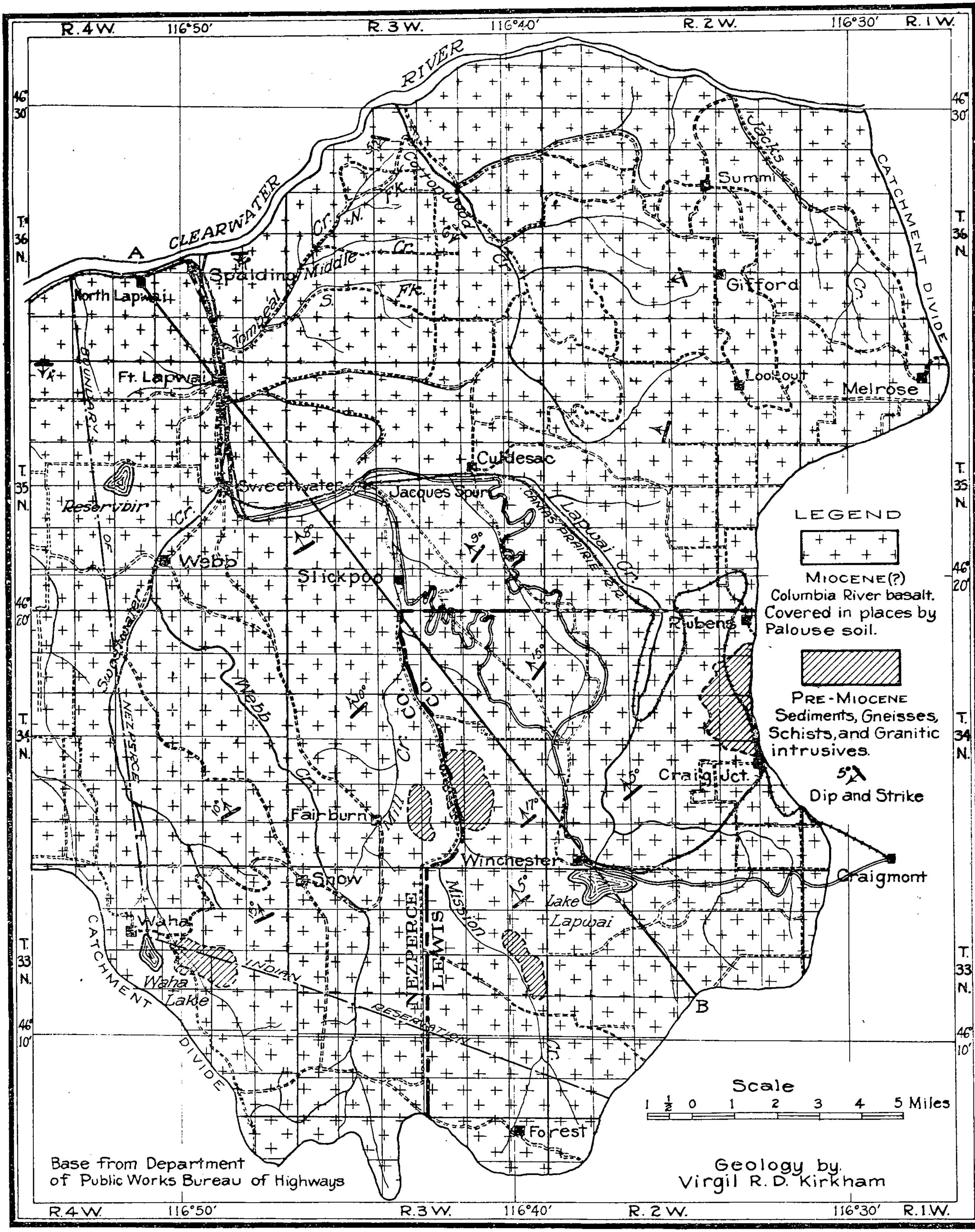
Farming, lumbering, and milling are the chief industries. The crest and upper flanks of Craig Mountain are well timbered. The upper parts of the canyons of Lapwai and Mission creeks also bear timber. The main roads occupy the stream valleys. The North and South Highway passes through Craigmont, Winchester, and winds with a 3,000 foot descent down to Culdesac. From there it extends west to Sweetwater, then north through Lapwai to Spalding. From there it follows the Clearwater to Lewiston about 12 miles distant. The region is served by the Camas Prairie Railroad. A branch line connects Winchester with Craig Junction.

G E O L O G Y[8]

STRATIGRAPHY AND PETROLOGY

So far as is known the oldest formation in the area is the black, or dark bluish gray, fossiliferous marble exposed at two places on or near Mission Creek east of Fairburn. Fossils collected by the writer from this formation were assigned a Triassic age by the United States Geological Survey.

Pre-lava terrane now exposed east of Waha Lake, (southwest of Lake Lapwai where Mission Creek cuts across the craig Mountain anticlinal axis,) and the area between Craig Junction and Reubens, is composed of a granitic rock which is essentially a coarse-grained diorite.[8] This is assumed to be a phase of the Idaho batholith[11] described more fully in the Orofino report on page 4. This intrusive batholithic type is exposed at many other places along the axis of the Craig Mountain fold but the area are too small to be represented on a map of the scale used.



GEOLOGIC SKETCH MAP OF THE REGION NEAR LAPWAI, IDAHO.

Columbia River Basalt and Interbedded Sediments

Fully 3,000 feet of this series[3,4,5,6,8] is known to underlie the larger part of this area. This thickness has been obtained from an examination of the bevelled edges of the plateau where the basalt flows have been eroded on Craig Mountain, and also by the log of a well drilled in Tammany Hollow, a few miles west of the area. At many places in the canyons on the plateau 15 flows are exposed.

At approximately 225 feet below the surface of the plateau occurs a layer of shale and sandstone.[8] This is about 150 feet thick and its non-resistant character causes it to be expressed in every canyon in the region as a narrow terrace or shoulder at a consistent depth below the plateau surface.

Openings by prospectors have revealed its character in numerous places. It is very extensive. Fossil collections which were obtained from this layer prove that it represents the Latah formation.[3,4,5] It lies between basalt flows as it does at other localities in Idaho. Still another series of shales clays and sandstones occurs at a point between 750 and 800 feet below the plateau surface. As yet none of the lower sedimentary beds have been determined as the Latah formation as no fossil collections have been made.

For a fuller description of the origin, nature, and character of the basalt and lake-bed sediments the reader is referred to the earlier discussion of these formations on pages 4 and 5.

STRUCTURE[8]

Lewiston lies near the center of a three cornered basin formed by the sinking of the one-time horizontal Columbia River basalt and interbedded lake beds, soil, and silt.

The original height of this plateau appears to have been near 2,500 or 2,600 feet. The downwarping of the vast area brought the surface flows as low as 700 feet above sea level, and on the northern flank of the sink the beds were slightly raised to a present height of about 3,000 feet above sea level. They form the Uniontown plateau.

The Clearwater monocline thus permits basalt flows, which are practically horizontal north of the Clearwater, to bend over for 2,000 feet before flattening and rising again south of the river. The flows often dip as much as 50 degrees to the south.

The southwestern flank of the triangular depression is the Blue Mountains uplift. This dome developed synchronously with the downwarp and carried the basalt flows, which are 700 feet above sea level at Lewiston, to a height of 5,000 feet at its summit. The lava flows dip at angles from 2° to 5° towards Lewiston.

The Craig Mountain anticline constitutes the southeastern flank of the triangle. This area lies on its northwestern slope except a few square miles which lie on the Clearwater monocline. The whole structure constitutes an ideal artesian basin such as is described in the earlier pages. This area, however, does not lie at the bottom of the basin but, on the other hand, presents an artesian slope with true artesian conditions, on which flowing wells may be expected at carefully chosen locations.

U N D E R G R O U N D   W A T E R   S U P P L Y

I N   T H E   L A P W A I   R E G I O N

According to Oscar H. Lipps, District Superintendent in charge of the Fort Lapwai Indian Agency, a supply sufficient for 200 people will meet the needs of the school. The annual increment in the catchment area is far in excess of the demand by school and town. The region has all the factors necessary to insure an adequate underground water supply.

A well drilled for oil a few years ago on the George King farm, about 1 1/2 miles north and east of Lapwai, passed through an aquifer at 125 feet, a water bearing sand at 400 feet, and reached "shale" at 1,000 feet. The well was 1,040 feet deep and has an 8-inch casing to 500 feet. The water stands within 100 feet of the top. The mouth of the well lies about 180 feet above the valley where the Agency is situated.

On the Ira King farm about a quarter of a mile west of the deep well, water comes to within 50 feet of the surface. The mouth of this well is lower in elevation than the deep well but higher than the Agency.

C O N C L U S I O N S

The writer is confident that a well, drilled in the valley flat at the Agency adjacent to the present pumping plant, would strike an adequate, potable water supply. Because of the difference in elevation of this well and those northeast of town, the water should rise to within a few feet of the surface or even possibly overflow when the same aquifers are tapped. A much deeper well drilled at the Agency location is almost sure of flowing production. A sufficient amount of water should be secured at a depth of a few hundred feet. This can easily be distributed through the present system.