DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

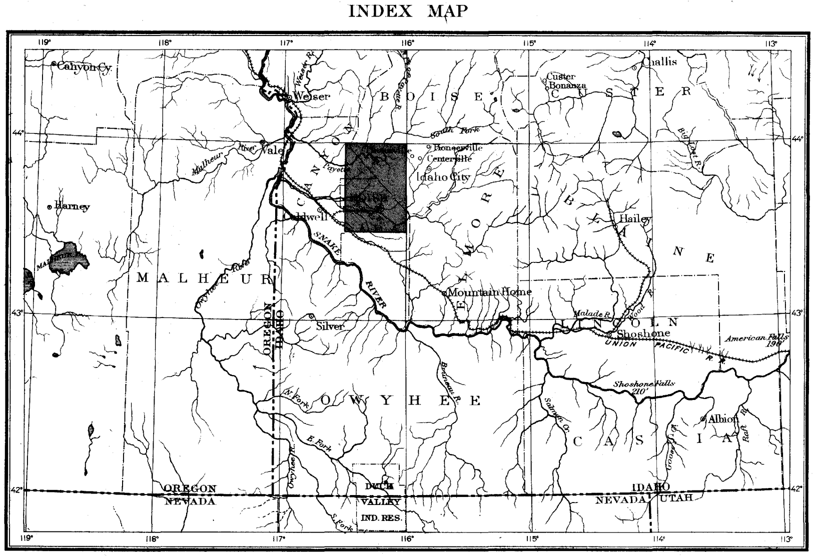
OF THE

UNITED STATES

BOISE FOLIO

IDAHO

INDEX MAP



SCALE: 40 MILES-1 INCH

AREA OF THE BOISE FOLIO

LIST OF SHEETS

DESCRIPTION | TOPOGRAPHY | HISTORICAL GEOLOGY | ECONOMIC GEOLOGY | STRUCTURE SECTIONS

FOLIO 45 LIBRARY EDITION BOISE

WASHINGTON, D. C.
ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY
BAILEY WILLIS, EDITOR OF GEOLOGIC MAPS S. J. KÜBEL, CHIEF ENGRAVER
1898

EXPLANATION.

The Geological Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two are being issued together in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and geologic maps of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called *drainage*, as streams, lakes, and swamps; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages, and cities.

Relief.—All elevations are measured from mean sea-level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the horizontal outline, or contour, of all slopes, and to indicate their grade or degree of steepness. This is done by lines connecting points of equal elevation above mean sea-level, the lines being drawn at regular vertical intervals. These lines are called *contours*, and the uniform vertical space between each two contours is called the *contour interval*. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map:

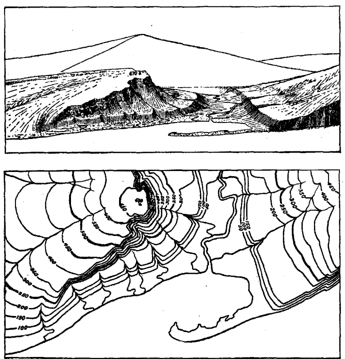


Fig. 1.—Ideal sketch and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a hooked sand-bar. On each side of the valley is a terrace. From the terrace on the right a hill rises gradually, while from that on the left the ground ascends steeply in a precipice. Contrasted with this precipice is the gentle descent of the left-hand slope. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates approximately a certain height above sea-level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, 200 feet, and so on, above sea-level. Along the contour at 250 feet lie all points of the surface 250 feet above sea; and similarly with any other contour. In the space between any two contours are found all elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours—say every fifth one—are accentuated and numbered; the heights of others may then be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing about prominences. The relations of contour curves and angles to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The vertical space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is used; for a steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is used for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like those in Colorado, the interval may be 250 feet. For intermediate relief contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. If the stream flows the year round the line is drawn unbroken, but if the channel is dry a part of the year the line is broken or dotted. Where a stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are also shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, and towns, together with boundaries of townships, counties, and States, and artificial details, are printed in black.

Scales.—The area of the United States (excluding Alaska) is about 3,025,000 square miles. On a map with the scale of 1 mile to the inch this would cover 3,025,000 square inches, and to accommodate it the paper dimensions would need to be about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this case it is "1 mile to an inch." The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "1 mile to an inch" is expressed by $\frac{1}{63,360}$. Both of these methods are used on the maps of the Geological Survey.

Three scales are used on the atlas sheets of the Geological Survey; the smallest is $\frac{1}{250,000}$, the intermediate $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale $\frac{1}{62,500}$ a square inch of map surface represents and corresponds nearly to 1 square mile; on the scale $\frac{1}{125,000}$, to about 4 square miles; and on the scale $\frac{1}{250,000}$, to about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three different ways, one being a graduated line representing miles and parts of miles in English inches, another indicating distance in the metric system, and a third giving the fractional scale.

Atlas sheets and quadrangles.—The map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The corresponding four-cornered portions of territory are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree, i. e., a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ contains one-quarter of a square degree; each sheet on the scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles, respectively.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to the boundary lines of the States, counties, or townships. To each sheet, and to the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet the names of adjacent sheets, if published, are printed.

Uses of the topographic sheet.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage, and culture of the district represented. Viewing the landscape, map in hand, every characteristic feature of sufficient magnitude should be recognizable. It should guide the traveler; serve the investor or owner who desires to ascertain the position and surroundings of property to be bought or sold; save the engineer preliminary surveys in locating roads, railways, and irrigation ditches; provide educational material for schools and homes; and serve many of the purposes of a map for local reference.

THE GEOLOGIC MAP.

The maps representing areal geology show by colors and conventional signs, on the topographic base map, the distribution of rock formations on the surface of the earth, and the structure-section map shows their underground relations, as far as known, and in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. The original crust of the earth was probably composed of *igneous rocks*, and all other rocks have been derived from them in one way or another.

Atmospheric agencies gradually break up igneous rocks, forming superficial, or *surficial*, deposits of clay, sand, and gravel. Deposits of this class have been formed on land surfaces since the earliest geologic time. Through the transporting agencies of streams the surficial materials of all ages and origins are carried to the sea, where, along with material derived from the land by the action of the waves on the coast, they form *sedimentary rocks*. These are usually hardened into conglomerate, sandstone, shale, and limestone, but they may remain unconsolidated and still be called "rocks" by the geologist, though popularly known as gravel, sand, and clay.

From time to time in geologic history igneous and sedimentary rocks have been deeply buried, consolidated, and raised again above the surface of the water. In these processes, through the agencies of pressure, movement, and chemical action, they are often greatly altered, and in this condition they are called *metamorphic rocks*.

Igneous rocks.—These are rocks which have cooled and consolidated from a liquid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through the igneous and sedimentary rocks of all ages molten material has from time to time been forced upward to or near the surface, and there consolidated. When the channels or vents into which this molten material is forced do not reach the surface, it either consolidates in cracks or fissures crossing the bedding planes, thus forming dikes, or else spreads out between the strata in large bodies, called sills or laccoliths. Such rocks are called *intrusive*. Within their rock enclosures they cool slowly, and hence are generally of crystalline texture. When the channels reach the surface the lavas often flow out and build up volcanoes. These lavas cool rapidly in the air, acquiring a glassy or, more often, a partially crystalline condition. They are usually more or less porous. The igneous rocks thus formed upon the surface are called *extrusive*. Explosive action often accompanies volcanic eruptions, causing ejections of dust or ash and larger fragments. These materials when consolidated constitute breccias, agglomerates, and tuffs. The ash when carried into lakes or seas may become stratified, so as to have the structure of sedimentary rocks.

The age of an igneous rock is often difficult or impossible to determine. When it cuts across a sedimentary rock, it is younger than that rock, and when a sedimentary rock is deposited over it, the igneous rock is the older.

Under the influence of dynamic and chemical forces an igneous rock may be metamorphosed. The alteration may involve only a rearrangement of its minute particles or it may be accompanied by a change in chemical and mineralogic composition. Further, the structure of the rock may be changed by the development of planes of division, so that it splits in one direction more easily than in others. Thus a granite may pass into a gneiss, and from that into a mica-schist.

Sedimentary rocks.—These comprise all rocks which have been deposited under water, whether in sea, lake, or stream. They form a very large part of the dry land.

When the materials of which sedimentary rocks are composed are carried as solid particles by water and deposited as gravel, sand, or mud, the deposit is called a mechanical sediment. These may become hardened into conglomerate, sandstone, or shale. When the material is carried in solution by the water and is deposited without the aid of life, it is called a chemical sediment; if deposited with the aid of life, it is called an organic sediment. The more important rocks formed from chemical and organic deposits are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the above sedimentary deposits may be separately formed, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Sedimentary rocks are usually made up of layers or beds which can be easily separated. These layers are called *strata*. Rocks deposited in successive layers are said to be stratified.

The surface of the earth is not fixed, as it seems to be; it very slowly rises or sinks over wide expanses, and as it rises or subsides the shore-lines of the ocean are changed: areas of deposition may rise above the water and become land areas, and land areas may sink below the water and become areas of deposition. If North America were gradually to sink a thousand feet the sea would flow over the Atlantic coast and the Mississippi and Ohio valleys from the Gulf of Mexico to the Great Lakes; the Appalachian Mountains would become an archipelago, and the ocean's shore would traverse Wisconsin, Iowa, and Kansas, and extend thence to Texas. More extensive changes than this have repeatedly occurred in the past.

The character of the original sediments may be changed by chemical and dynamic action so as to produce metamorphic rocks. In the metamorphism of a sedimentary rock, just as in the metamorphism of an igneous rock, the substances of which it is composed may enter into new combinations, or new substances may be added. When these processes are complete the sedimentary rock becomes crystalline. Such changes transform sandstone to quarzite, limestone to marble, and modify other rocks according to their composition. A system of parallel division planes is often produced, which may cross the original beds or strata at any angle. Rocks divided by such planes are called slates or schists.

Rocks of any period of the earth's history may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known, though generally the most altered, in some localities remain essentially unchanged.

Surficial rocks.—These embrace the soils, clays, sands, gravels, and bowlders that cover the surface, whether derived from the breaking up or disintegration of the underlying rocks by atmospheric agencies or from glacial action. Surficial rocks that are due to disintegration are produced chiefly by the action of air, water, frost, animals, and plants. They consist mainly of the least soluble parts of the rocks, which remain after the more soluble parts have been leached out, and hence are known as residual products. Soils and subsoils are the most important. Residual accumulations are often washed or blown into valleys or other depressions, where they lodge and form deposits that grade into the sedimentary class. Surficial rocks that are due to glacial action are formed of the products of disintegration, together with bowlders and fragments of rock rubbed from the surface and ground together. These are spread irregularly over the territory occupied by the ice, and form a mixture of clay, pebbles, and bowlders which is known as till. It may occur as a sheet or be bunched into hills and ridges, forming moraines, drumlins, and other special forms. Much of this mixed material was washed away from the ice, assorted by water, and redeposited as beds or trains of sand and clay, thus forming another gradation into sedimentary deposits. Some of this glacial wash was deposited in tunnels and channels in the ice, and forms characteristic ridges and mounds of sand and gravel, known as osars, or eskers, and kames. The material deposited by the ice is called glacial drift; that washed from the ice onto the adjacent land is called modified drift. It is usual also to class as surficial rocks the deposits of the sea and of lakes and rivers that were made at the same time as the ice deposit.

AGES OF ROCKS.

Rocks are further distinguished according to their relative ages, for they were not formed all at one time, but from age to age in the earth's history. Classification by age is independent of origin; igneous, sedimentary, and surficial rocks may be of the same age.

When the predominant material of a rock mass is essentially the same, and it is bounded by rocks of different materials, it is convenient to call the mass throughout its extent a *formation*, and such a formation is the unit of geologic mapping.

Several formations considered together are designated a *system*. The time taken for the deposition of a formation is called an *epoch*, and the time taken for that of a system, or some larger fraction of a system, a *period*. The rocks are mapped by formations, and the formations are classified into systems. The rocks composing a system and the time taken for its deposition are given the same name, as, for instance, Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be discovered by observing their relative positions. This relationship holds except in regions of intense disturbance; sometimes in such regions the disturbance of the beds has been so great that their position is reversed, and it is often difficult to determine the relative ages of the beds from their positions; then *fossils*, or the remains of plants and animals, are guides to show which of two or more formations is the oldest.

Strata often contain the remains of plants and animals which lived in the sea or were washed from the land into lakes or seas or were buried in surficial deposits on the land. Rocks that contain the remains of life are called fossiliferous. By studying these remains, or fossils, it has been found that the species of each period of the earth's history have to a great extent differed from those of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present.

When two formations are remote one from the other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first.

Fossil remains found in the rocks of different areas, provinces, and continents, afford the most important means for combining local histories into a general earth history.

Colors and patterns.—To show the relative ages of strata, the history of the sedimentary rocks is divided into periods. The names of the periods in proper order (from new to old), with the color or colors and symbol assigned to each, are given in the table in the next column. The names of certain subdivisions of the periods, frequently used in geologic writings, are bracketed against the appropriate period name.

To distinguish the sedimentary formations of any one period from those of another the patterns for the formations of each period are printed in the appropriate period-color, with the exception of the first (Pleistocene) and the last (Archean). the Pleistocene and the Archean, are distinguished from one another by different patterns, made of parallel straight lines. Two tints of the period-color are used: a pale tint (the underprint) is printed evenly over the whole surface representing the period; a dark tint (the overprint) brings out the different patterns representing formations.

Period.	Symbol.	Color.
Pleistocene	P	Any colors.
Neocene { Pliocene / Miocene }	N	Buffs.
Eocene (including Oligocene)	E	Olive-browns.
Cretaceous	K	Olive-greens.
Juratrias { Jurassic / Triassic }	J	Blue-greens.
Carboniferous (including Permian)	C	Blues.
Devonian	D	Blue-purples.
Silurian (including Ordovician)	S	Red-purples.
Cambrian	Є	Pinks.
Algonkian	A	Orange-browns.
Archean	Æ	Any colors.

Each formation is furthermore given a letter-symbol of the period. In the case of a sedimentary formation of uncertain age the pattern is printed on white ground in the color of the period to which the formation is supposed to belong, the letter-symbol of the period being omitted.

The number and extent of surficial formations of the Pleistocene render them so important that, to distinguish them from those of other periods and from the igneous rocks, patterns of dots and circles, printed in any colors, are used.

The origin of the Archean rocks is not fully settled. Many of them are certainly igneous. Whether sedimentary rocks are also included is not determined. The Archean rocks, and all metamorphic rocks of unknown origin, of whatever age, are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color, and may be darker or lighter than the background. If the rock is a schist the dashes or hachures may be arranged in wavy parallel lines. If the rock is known to be of sedimentary origin the hachure patterns may be combined with the parallel-line patterns of sedimentary formations. If the metamorphic rock is recognized as having been originally igneous, the hachures may be combined with the igneous pattern.

Known igneous formations are represented by patterns of triangles or rhombs printed in any brilliant color. If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters which suggest the name of the rocks.

THE VARIOUS GEOLOGIC SHEETS.

Historical geology sheet.—This sheet shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any particular colored pattern and its letter-symbol on the map the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the symbols and names are arranged, in columnar form, according to the origin of the formations—surficial, sedimentary, and igneous—and within each group they are placed in the order of age, so far as known, the youngest at the top.

Economic geology sheet.—This sheet represents the distribution of useful minerals, the occurrence of artesian water, or other facts of economic interest, showing their relations to the features of topography and to the geologic formations. All the formations which appear on the historical geology sheet are shown on this sheet by fainter color-patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A symbol for mines is introduced at each occurrence, accompanied by the name of the principal mineral mined or of the stone quarried.

Structure-section sheet.—This sheet exhibits the relations of the formations beneath the surface. In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits those relations is called a *section*, and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface, draw sections which represent the structure of the earth to a considerable depth, and construct a diagram exhibiting what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

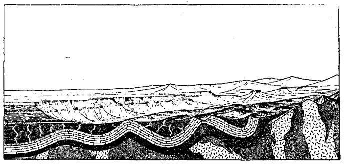


Fig. 2.—Sketch showing a vertical section in the front of the picture, with a landscape beyond.

The figure represents a landscape which is cut off sharply in the foreground by a vertical plane that cuts a section so as to show the underground relations of the rocks.

The kinds of rock are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

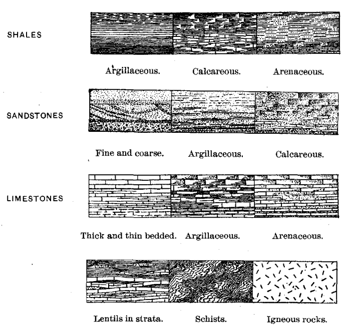


Fig. 3.—Symbols used to represent different kinds of rock.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section.

The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to beds of sandstone that rise to the surface. The upturned edges of these beds form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining, or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But these sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets. That they are now bent and folded is regarded as proof that forces exist which have from time to time caused the earth's surface to wrinkle along certain zones.

On the right of the sketch the section is composed of schists which are traversed by masses of igneous rock. The schists are much contorted and their arrangement underground can not be inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

In fig. 2 there are three sets of formations, distinguished by their underground relations. The first of these, seen at the left of the section, is the set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has swelled upward from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their positions, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets, marking a time interval between two periods of rock formation, is another unconformity.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections in the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the depth of any mineral-producing or water-bearing stratum which appears in the section may be measured from the surface by using the scale of the map.

Columnar-section sheet.—This sheet contains a concise description of the rock formations which occur in the quadrangle. The diagrams and verbal statements form a summary of the facts relating to the character of the rocks, to the thicknesses of the formations, and to the order of accumulation of successive deposits.

The rocks are described under the corresponding heading, and their characters are indicated in the columnar diagrams by appropriate symbols. The thicknesses of formations are given under the heading "Thickness in feet," in figures which state the least and greatest measurements. The average thickness of each formation is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement: the oldest formation is placed at the bottom of the column, the youngest at the top, and igneous rocks or other formations, when present, are indicated in their proper relations.

The formations are combined into systems which correspond with the periods of geologic history. Thus the ages of the rocks are shown, and also the total thickness of each system.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition of sediments may be indicated graphically or by the word "unconformity," printed in the columnar section.

Each formation shown in the columnar section is accompanied by its name, a description of its character, and its letter-symbol as used in the maps and their legends.

CHARLES D. WALCOTT,
Director.

DESCRIPTION OF THE BOISE QUADRANGLE.

GEOGRAPHY.

Extent of quadrangle.

The Boise quadrangle lies between the meridians 116° and 116° 30′ west longitude and the parallels 43° 30′ and 44° north latitude, being 34.5 miles long and 25.1 miles wide, and contains 863.82 square miles. It embraces portions of Ada, Boise, and Canyon counties, Ada occupying most of the southwestern and Boise the whole of the northeastern part.

Bottom lands and mesas.

Relief.—The quadrangle is situated on the northern side and near the western end of the great Snake River Valley, which extends through the entire width of southern Idaho. In general, the southwestern half consists of mesas and flood plains, lacustrine and fluviatile in origin, formed in this great valley during Neocene and Pleistocene times. The northeastern half is made up of older rocks, chiefly granite, rising in ridges with decided relief, the most prominent of which is Boise Ridge, following the eastern boundary line. The highest elevation attained is 7500 feet, at Shafer Butte, sometimes also called Bogus Mountain. The lowest elevation, a little below 2500 feet, is found at Boise River at the western boundary of the quadrangle. Alluvial bottom lands, at some places 3 miles wide, follow Boise River from a point 8 miles southeast of the city of Boise to the western boundary, and the Payette from the crossing of the line between Boise and Canyon counties to the same boundary line. Low mesas covered with fertile soil flank the bottom lands and are very extensive along Boise River. Successively higher mesas are met with southward, culminating in the gravel ridge near the southern boundary at elevations of from 3100 to 3500 feet. A still higher table-land, extensively dissected by gulches and ravines, lies in front of the mountains and attains elevations of from 3500 to 4000 feet. Beginning at Table Rock, 3 miles southeast of Boise, it extends, gradually widening, up to the northwestern corner of the quadrangle. Isolated rounded complexes of hills or short ridges rise in the upper half of the quadrangle, along the eastern margin of this dissected mesa; such are Squaw Butte, culminating just beyond the northern boundary, Crown Point and Prospect Peak, the ridge east of Squaw Creek, and the several ridges between Horseshoe Bend and Dry Creek, all attaining elevations of from 4500 to 5500 feet.

Boise Ridge.

Boise Ridge is the most prominent feature of the quadrangle, and extends, with its projecting spurs, along the eastern boundary line. Its crest line, though irregular in detail, runs as a whole exactly north and south and lies between 1 and 5 miles west of longitude 116°. Its summit is marked by a number of peaks and short, level-topped ridges separated by wind gaps. The flat summit ridges are well marked about Lucky Peak and north of Hawkins toll road. Near the southeastern corner the ridge is terminated by the canyon of Boise River, close to its debouchure into the plains. Five miles north of the river the ridge attains its first culminating point in Lucky Peak, the broad shoulder of which reaches an elevation of 5800 feet. It continues northward with increasing elevation, culminating in Shafer Butte. The average height is, however, greatest in the northern part of the quadrangle, here attaining 6500 feet, with isolated peaks rising to 7200 feet. Two low gaps are notched in the ridge, one 3 miles north of Lucky Peak, where the Idaho City road crosses it at an elevation of only 5000 feet, and farther north at Hawkins toll road, the pass of which has an elevation of 5500 feet. Boise Ridge continues as a well-marked feature at least 15 miles north of the northern boundary line of this quadrangle. A maze of projecting spurs and deeply incised ravines makes the ridge attractive and picturesque, though it lacks the grandeur of the more elevated ranges. The summit of Shafer Butte affords a most impressive view, reaching over the Boise Mountains to the Sawtooth Range on the east, and over the broad Snake River Valley to the Owyhee Mountains and far into Oregon on the west.

Boise River and its tributaries.

Drainage.—The southern and larger part of the quadrangle is drained by Boise River, a tributary of the Snake, having a watershed of 3400 square miles embracing much of the central mountain region of the State; the narrow strip east of Boise Ridge also drains to the same river, all of the water courses flowing into Moore Creek, itself a tributary of the Boise. Ten miles southeast of Boise the river debouches from a deep granite canyon, and, turning to the northwest, continues its course through a broad alluvial valley until, 30 miles farther down, it joins Snake River. The grade of the river approximates 10 feet to the mile. Numerous smaller tributaries, the largest among which are Dry Creek and Willow Creek, each with a drainage area of about 63 square miles, join it from the mountains and mesas on the north side, while the creeks draining the flat mesa on the south side flow into it some distance west of the western boundary line of this quadrangle.

The northern third of the quadrangle is drained by the Payette, another tributary of the Snake, having a watershed of about 3300 square miles adjoining that of the Boise to the north. The Payette pursues a winding course through narrow canyons and through the intermontane valleys of Jerusalem, Horseshoe Bend, and Marsh. Its grade averages 8 feet to the mile. Ten miles below Marsh it debouches into a wide, open valley, continuous nearly down to the Snake. It receives the important tributary of Squaw Creek from the north and several large creeks from the western slope of Boise Ridge.

Climate.—The whole of the Snake River Valley is in the arid zone and its climate and vegetation are closely allied to those of the Great Basin. The Pacific meteorological influences make themselves strongly felt and the climate of the valleys may be characterized as mild. The precipitation is somewhat larger than in the Great Basin, and the vegetation is consequently somewhat less scanty. In the valleys the temperature may reach 105° F. for a few days in summer; in winter it rarely sinks to 0° F., though a temperature of −27° F. has twice been recorded in Boise. The mean annual temperature at Boise ranges from 50° to 53° F. The winds are generally southwesterly, and rarely very strong, but they often carry a considerable quantity of dust. The annual precipitation at Boise varies from 4 to 15 inches, the largest amount occurring between December and May, although there are occasional showers in summer. In ordinary winters but little snow falls in the valleys. At higher elevations the climate is naturally more severe; at 4500 feet snow several feet deep may accumulate and remain for many months.

Vegetation.—The vegetation is, on the whole, very scanty. Along the river bottoms and perennial creeks deciduous trees, such as cottonwoods, alders, and aspens, grow. The extensive terraces and mesas in the southwestern portion are covered with sagebrush, sometimes reaching a height of 10 feet. On the lower foothills no trees or bushes grow, but during spring and summer they are covered by a flora of nutritious grasses and many flowering herbs, all of which generally dry up about July 1. The dissected mesa of the Payette formation in the central-western part is, on the whole, the most barren portion of the quadrangle. At elevations of about 4500 feet scattered pines begin to appear on the western slope of Boise Ridge, and a little higher up are forests of coniferous trees, pines and firs. They are more luxuriant and reach to lower elevations on the eastern than on the western side of the ridge. There is also much underbrush, which makes portions of the northern Boise Ridge almost inaccessible. The forest belt in this quadrangle thus occupies only a narrow area along the eastern boundary line.

Agricultural lands.

Culture.—The population of the quadrangle is estimated to be about 8000. Boise, the capital of Idaho, is located in this quadrangle, and has a population of about 5000. Smaller towns are Pearl, in the Willow Creek mining district, and Meridian, on the line of the railroad connecting Boise with Nampa. The principal industries are agriculture, cattle raising, mining, and timber cutting. The agricultural lands are confined chiefly to the southwestern portion, which, with its river bottoms and alluvial mesas, forms a part of the rich farming country of the lower Snake River Valley. The total area which can be brought under cultivation with the present ditches from the Boise is 117 square miles. The level mesas rising on both sides of Boise River to a height of from 50 to 100 feet are covered with rich soil and produce excellent crops wherever water is available. Payette Valley, in the northeastern corner, contains within this quadrangle 12 square miles, a part of which is already brought under cultivation. Along Marsh Valley and Squaw Creek there are approximately 12 square miles of agricultural land. Horseshoe Bend and Jerusalem valleys contain 6 square miles which are or can be brought under cultivation. Smaller areas of agricultural land are found along Willow Creek, Dry Creek, and other smaller water courses. The largest part of the quadrangle is adapted to grazing, and in ordinary seasons produces an abundance of nutritious grasses.

Lumbering, mining, and other industries.

Timber cutting is, as above remarked, confined to a zone on the high Boise Ridge along the eastern boundary line. Sawmills were at work in 1896 at the head of Daggett Creek, a short distance north of the Idaho City toll road. Quartz mining is carried on in several small districts, the most important of which are the Willow Creek and Rock Creek mining districts in the northern part of the quadrangle and the Black Hornet and Shaw Mountain districts in the southeastern corner. A railroad connects Boise with Nampa on the Oregon Short Line, the main trunk of which cuts across the southwestern corner. Many roads connect the different parts of the quadrangle, though some of them are scarcely passable in winter by reason of heavy rains and frequent washouts. Three principal roads cross Boise Ridge and lead over into Idaho Basin—Idaho City toll road, Hawkins toll road, and Jerusalem road.

Irrigation.

Water supply.—As a rule, crops can be raised without irrigation only in the river bottoms, so that elsewhere it is necessary to resort to artificial watering. Boise and Payette rivers form the principal sources, and numerous ditches taken from them cover the agricultural lands on both sides of Boise River. The mean flow of Boise River, according to preliminary measurements made in 1895 by the United States Geological Survey, is from 916 to 6026 second-feet, the minimum occurring in December and the maximum in May. Six principal ditches carry water to the alluvial flats and mesas on both sides of the river. A canal which would cover the larger part of the upper mesa on the south side of the river was begun some years ago, but never completed. Payette River in 1895 had a mean flow of 988 second-feet during November and of 13,137 second-feet in May. The southern side of the Payette Valley is under cultivation by means of a ditch taken out at the mouth of the canyon, 6 miles from the eastern boundary of the quadrangle. The higher mesa on the north side is as yet not under water. In many places, for instance, along Dry Creek, water is available only during the earlier part of the season, but is sufficient to provide for one crop of hay. Within the mountain region springs are abundant, and many of them are used locally for irrigation. The sandy mesa between the lower Payette and Boise rivers is poorly watered and contains but few springs. In the bottom lands potable water is usually obtained in wells of slight depth, but on the higher mesas the ground-water level stands but little higher than along the river and the wells must be from 50 to 100 feet deep.

GEOLOGY.

GEOLOGICAL HISTORY OF LOWER SNAKE RIVER VALLEY.

General features.—Before entering upon the detailed description of the formations, it is desirable briefly to mention the chief geological features of the lower Snake River Valley and to outline the events which have taken place in its geological history.

General features of the Snake River Valley.

The Snake River Valley stretches across the whole width of southern Idaho in a broad curve opening toward the north and with a radius of about 160 miles. The length of this valley from the base of the Tetons to Weiser, where the river enters a deep and narrow canyon, is over 400 miles, while its width ranges from 50 to 125 miles, a total area of about 24,000 square miles. The average grade of the river is 7 feet to the mile; the elevations range from 5000 feet in the eastern part of the valley to 2125 feet at Weiser. On both sides of this valley rise high ranges of older rocks, while the valley itself and the foothills are covered by Neocene and Pleistocene deposits and lava flows. The larger part of the valley is occupied by vast flows of basalt, resting upon and covered by fluviatile and lacustrine accumulations. Through this series the river has cut a canyon rarely reaching 800 feet in depth. In the western half of the valley there are no extensive bottom lands along the basalt canyon of Snake River until a point about 30 miles south of Weiser is reached. At this locality a number of tributaries join the river, the most important being the Boise, the Payette, and the Owyhee. Along this lower part of the valley there are level bottom lands and broad terraces, forming one of the principal agricultural regions of the State. Between the lower courses of the Payette and the Boise, as well as north of the Payette, extend complexes of flat-topped hills of soft material, extensively dissected by streams and rising to elevations of 800 and even 1000 feet above the rivers.

The mountain region adjacent to the valley.

The higher mountain regions of older rocks surrounding the trough of Snake River Valley rise gradually on the north side of the river beyond the sloping mesa of Tertiary rocks. This mountain region, extending up to the Sawtooth Range, which divides the waters of the Boise and the southern branches of the Payette from those of the Salmon, has an average width of 55 miles and culminates in summits with an elevation of from 10,000 to 11,000 feet. It does not form a well-defined range, but rather a broad uplift dissected deeply and in the most intricate manner by the forks of the Boise and the Payette. The summits of the narrow ridges usually form gently sloping lines. If a surface were constructed containing all these lines it would be of undulating, curved character, sloping gently from elevations of 9000 down to 4000 feet. From the southwestern edge a steeper slope carries the granitic rocks below the surface of the Tertiary rocks of Snake River Valley. The canyons of the Boise and the Payette have cut down into the uplift to a maximum depth of 3000 feet, and are joined by deep lateral canyons, dividing the whole region into a maze of narrow arêtes. The grade of the main rivers is from 10 feet up to 50 feet to the mile, and only well up toward the head waters are grades of 100 feet to the mile attained. The grades of the lateral canyons are also often relatively small in their lower course, but near their head waters rise extremely steep cirques. The Idaho Basin quadrangle offers excellent illustrations of these relations, which are the result partly of the antiquity of the drainage, partly of the crumbling character of the granite.

Migration of the main divide.

At the main divide (Bear Valley quadrangle) the broad valleys and gentler slopes of the Salmon River drainage contrast strongly with the deeply incised canyons of the Boise and Payette; the latter streams are continually capturing territory belonging to the former, and the divide is in process of migration to the northeast. The whole region may be regarded as an uplifted sloping plateau deeply dissected by a drainage the origin of which dates far back in the Tertiary period. Within this mass of mountains several depressions or basins with gentler slopes exist, such as Idaho Basin, Deadwood Basin, and Smiths Prairie, which have been created or emphasized by more recent mountain-making movements. Evidences of glacial topography occur only near the Sawtooth and Trinity mountains. The lower area here specially described has never been covered by ice.

Granite, its age and mineral deposits.

Pre-Neocene.—The oldest rock exposed is the granite. This forms an extremely large area, embracing, as far as known, the Owyhee Mountains and the whole of the upper drainage of Boise and Payette rivers, and extending beyond the Sawtooth Mountains to the northeast and to Wood River on the east, where it is adjoined by sedimentary rocks of probably Carboniferous age. Dikes of quartz-porphyry, granite-porphyry, and various dioritic and syenitic rocks abound in the granite area, but it contains, so far as known, very few masses of schistose or sedimentary rocks. It weathers easily and crumbles to a coarse sand on the summits and slopes of the ridges. The age of this granite, which is clearly of igneous and intrusive origin, is an open question. It has tentatively been referred to the Archean, but a thorough study of its contact lines is necessary before the problem can be solved. Most of the gold and silver deposits of the region occur in this granite as fissure veins, but as to their age there are few definite clues. It is probable, however, that the mineral deposits are post-Carboniferous, and it is certain that they antedate the Miocene lake deposits. They may, with some probability, be assigned to a Cretaceous or Eocene age. The mode of their occurrence indicates beyond doubt an origin by deposition from mineral waters, probably ascending hot springs. A slight recurrence of the vein-forming activity occurred after the Neocene period.

Before the beginning of the Neocene period the chief features of the topography were outlined — the broad uplift of the Boise Mountains and the depression of Snake River Valley. (*Pre-Neocene topography.*) The latter is not unlikely a sunken area, separated by old fault lines from the mountains to the north. At that time the basalt flows and the lake beds did not exist, but the drainage of the Boise was outlined in practically its present form. The granitic range presented a bold scarp facing the valley, and the canyon of Boise River was, at its debouchure from the mountains, cut to practically the same depth it has at present. It had not, of course, cut back so far toward the Sawtooth Range as at present, and many features of the drainage, notably in Idaho Basin, were different from those existing now. As substantiating this, it will be shown that early Neocene lake beds filled the old canyon at the gate of the mountains, 10 miles southeast of Boise, and that in front of it lie enormous masses of coarse Neocene gravel and conglomerate. Thus the time immediately preceding that from which the first records date was one, first, of uplift and subsidence, during which the rough features were blocked out, and second, of long-continued erosion, during which the Boise Mountains were dissected and the débris from the excavated canyons was deposited in the basin of Snake River Valley, where it is now deeply covered below later formations. If we should venture tentatively to go back one step further, it might be suggested that the uplifted surface of the Boise Mountains probably is the result of a far older erosion, of early Tertiary or Cretaceous age, which planed down a more ancient range to gentle profiles, or to a peneplain.

Payette formation.—During the earlier part of Neocene (Miocene) a large fresh-water lake occupied Snake River Valley, and its sediments are now prominent features of the region. (*Extensive Neocene lake deposits.*) For these lake beds the name Payette formation is proposed, and their age is determined as upper Miocene. The formation is extensive. It lies in front of the Boise Mountains and occupies the whole lower part of the ridge between the Boise and the Payette. It extends over large areas to the north of the Payette, along the flood plains of Snake River, and is seen to occupy vast areas in Oregon between the mouth of Owyhee River and Weiser, where Snake River Canyon begins. On both sides of the lower Snake River the bluffs of the Payette formation attain a height of over 800 feet. In Payette Valley south of Emmett the sharply defined bluff of Payette beds rises 600 feet above the alluvium. Smaller masses, detached by erosion or uplifts, lie in the intermontane valleys as far east as Idaho Basin.

Along Boise Ridge the Payette beds rest against the irregular and sharply sloping surface of the granite, and the top stratum attains a height of 4100 feet. A total thickness of 800 feet is exposed near Boise, and wells bored show several hundred feet of similar strata below the surface. Over the larger part of its extent the formation lies nearly horizontal or dips only a few degrees. Near the mountains dips of 8° to 10°, generally westward, are noted, and the smaller detached masses in the intermontane valleys are still more disturbed, generally dipping at angles up to 50°. This is particularly marked in the long arm of sediments of the Payette formation filling the valleys of Horseshoe Bend and Jerusalem, on the Payette.

A number of fossil leaves have been found in different places in the Payette formation, and its age is determined from this line of evidence. (*Fossil leaves in the lake beds.*) It is apparent that the Payette formation is approximately contemporaneous with that series of beds which in the basin of Columbia River has been described as the John Day formation, but it is probable that this lake was separated from that of John Day Basin by the ridge of the Blue Mountains crossing Snake River north of Weiser and connecting with the Salmon River Mountains. During the time of the maximum extension of the Payette lake, its surface stood at the present elevation of 4100 feet. Its deposits, over 1000 feet thick near the shore, rested against the abrupt slope of Boise Ridge and filled the old canyon of the Boise to the same depth.

Early Neocene volcanic activity.—During the early part of the Payette epoch eruptions of rhyolite occurred, but these were of minor extent. During the earlier and middle part of the same epoch large eruptions of basaltic lavas took place. (*Lavas interbedded with the sediments.*) These eruptives become more abundant northward. Large masses of them are found in the northern part of the Boise quadrangle, and they appear again on a large scale north of Weiser.

Post-Payette erosion.—After attaining its highest stage the lake was drained through the present course of Snake River below Weiser. The lake receded as the canyon was rapidly eroded by the mighty volume of water, and in the lower Snake River Valley this erosion has proceeded since the end of the Miocene or the beginning of the Pliocene, but in later times with temporary elevations of the base-level, resulting in the formation of alluvial terraces along the rivers. The broad valleys of the Boise, the Payette, and the lower Snake River were eroded in the soft lake beds. The accumulated gravels were scoured out from the canyon of Boise River and, before the Pliocene basaltic eruptions, its channel was deepened nearly to its present level.

Post-Payette orogenic disturbances.—Before the epoch of the Pliocene basalt flows, the sediments and volcanic flows of the Payette formation were subject to some disturbances, reaching their maximum in the smaller areas in the intermontane valleys. Certain parts of the series acquired a slight westerly dip. More intense orogenic movements took place at Squaw Butte and in the Horseshoe Bend and Jerusalem valleys, resulting in monoclinal uplifts, the more detailed character of which will be discussed later. Over the larger part of its area no orogenic movements have affected the beds.

Snake River basalts (*Pliocene*).—During the later part of the Neocene, vast basaltic eruptions began and in time filled the whole of the Snake River Valley from the base of the Tetons, near the Wyoming line, to a point near the confluence of the Boise and the Snake. (*Vast basaltic eruptions.*) Between this point and Weiser none are seen. The basalt flows lie horizontal, filling the valleys and the canyons, and are often interbedded with lake beds or river gravels; they are also distinguished by their fresh character, black color, and columnar structure. The aggregate thickness probably never exceeds 1000 feet, and is ordinarily much less.

The basalts were erupted from a great number of inconspicuous craters, both in the plains and in the adjoining mountains. Their fluidity was remarkable, continuous flows of 50 miles or more being noted. One flow, for instance, followed the South Fork of Boise River for that distance down to its mouth. The age of these later basalts is late Neocene (Pliocene), though minor eruptions may have continued into the Pleistocene.

Late Neocene lake beds.—During the eruptions of the Pliocene basalt the extensive Payette lake had dwindled to smaller dimensions. (*The Pliocene lake.*) Its shore line for some time probably remained stationary at an elevation of 2700 or 2800 feet, but in this quadrangle there are few marks left of its existence, as most of these later lake beds have been obliterated by Pleistocene river wash. Along Snake River, from above Glenns Ferry down to near Nampa, late Neocene (Pliocene) lake deposits are found as white clays and sands interbedded with thin basalt flows and well exposed in the river bluffs.

Post-basaltic erosion.—Placing the epoch of the basaltic flows at the very close of the Neocene, the events that have taken place since then are referred to the Pleistocene. To these belong the erosion of the canyons of Snake River and its tributaries to a depth of from 200 to 700 feet, and the deposition of extensive flood plains and terraces along the lower Snake, Boise, and Payette. Boise River has in Pleistocene times cut through the 300 feet of basalt accumulated at the mouth of its canyon, and thus laboriously regained the same stage it occupied before the beginning of the Payette epoch.

DETAILED DESCRIPTION.

PRE-NEOCENE ROCKS.

This series comprises the prevailing granites, the diorites, and the accompanying dike rocks of granitic, dioritic, or syenitic character, all of uncertain age.

Granite.—The granite occupies about one-third of the total area of the Boise quadrangle, chiefly in its northeastern portion. (*Extent of the granite.*) It generally borders against the Payette formation on the west, while on the east and northeast it extends far up toward the Sawtooth Range. The topography of the area is characterized by abrupt slopes and deeply incised gulches, its most prominent features being Boise Ridge, with its projecting spurs, and the more irregular complex extending north-northeast from Crown Point Hill. A slope steeper than that of the average ridge lines carries the formation below the Payette beds on the west.

Over a large part of the area the granite has a very uniform character. It is coarse grained, the average size of the constituents being 4 to 5 mm.; larger orthoclase crystals, attaining 3 cm. or even more in diameter, often occur, and give a porphyritic aspect to the rock. (*Character and composition of the granite.*) The color of the fresh rock is light gray, but weathering soon gives it a yellowish-gray tint, caused chiefly by the decomposition of the biotite. It consists of large quartz grains, plagioclase, orthoclase, and biotite in small flakes; moscovite occurs in some of the more acid varieties. A little apatite and magnetite are also usually noted. Micropegmatite is of fairly common occurrence. Microcline is, on the whole, rare. The plagioclase is, as a rule, an oligoclase. The rock has a characteristic granitic structure; none of the constituents show markedly developed crystalline forms. Evidence of deformation by pressure is rarely noted among the constituents.

No analysis has yet been made of the normal rock, but it is, without much doubt, a typical granite, containing, however, a considerable amount of soda. The percentage of silica must considerably exceed 65.

Near Pearl and Crown Point, and extending thence up across Payette River, the granite is of a more basic character. This rock is also of gray color, but contains more ferro-magnesian silicates than the normal rock. A green hornblende occasionally appears beside the biotite. While there is about 10 per cent orthoclase, the predominant feldspar is a basic oligoclase, but labradorite has also been noted in one specimen. Brown titanite and a little magnetite always occur. Except in the scarcity of hornblende the rock is similar to the granodiorite of the Sierra Nevada, California, which is intermediate between granite and diorite; but as it occupies only a relatively small area and is connected by transition with more normal granite, it has not been considered advisable to separate it from the prevailing rock. Similar rocks also occur on Shafer Creek 2 miles southeast of Horseshoe Bend. An analysis of the Willow Creek granite yielded 65 per cent silica, 3.9 per cent lime, 1.3 per cent magnesia, 3.5 per cent iron oxides, 3 per cent potassa, and 3.6 per cent soda.

The slopes and ridges of the granite area are ordinarily covered by disintegrated rock, forming a coarse, sandy mass, of yellowish-gray or gray color, easily swept away by violent rain storms. (*Great thickness of disintegrated rock.*) Whole hillsides are sometimes carried away by cloudbursts, and deep cuts are scored along the ravines in a day. Fresh hard rock occurs, as a rule, only along the canyons or on the highest summits. The whole area bears clear evidence of having been exposed to weathering and disintegration during geological epochs, and no ice sheet ever swept away the accumulated sand masses. Had it not been retarded by the long lake period during the early Neocene, erosion would have planed down the Boise Mountains to a far greater extent.

The granite of Boise Ridge is traversed by an extensive system of shear planes, producing a jointing or sheeting of the rock. (*Shear planes in the older rocks.*) The spacing of the joints is ordinarily from 6 inches to several feet. The direction is, as a rule, E.–W. or ENE.–WSW., the dip being either northward or southward from 50° to 80°. More rarely another system appears with northeasterly direction and southwesterly dip. This conjugated system of joints is, in all probability, produced by a compressive stress identical with or similar to that causing the fissures of the gold-quartz veins in the same district. It is probable that some movement has taken place on each of these joint planes, though in most cases it is so small that it is not easily observed.

Diorite.—The basic variety of the granite, which occurs near Pearl and Crown Point and which is intermediate in composition between typical granite and diorite, has been described under "Granite." (*Character and composition of the diorite.*) A still more basic variety, which belongs to the diorites, occurs at Horseshoe Bend and extends for a distance of 3 miles down Payette Canyon, bordering on the south against a dike of diorite-porphyrite and on the north against the dioritic granite, with very indistinct and ill-defined contact. This rock varies much in appearance, from dark gray, medium grained or slightly porphyritic to coarse granular, the latter consisting apparently of white feldspar and rather abundant green hornblende. It carries abundant plagioclase, generally a labradorite, and only occasionally a little orthoclase. Green hornblende, biotite, and a little quartz are usually present, and it contains augite, partly converted into hornblende. The rocks may be characterized as pyroxene-diorites. The dark-gray, somewhat porphyritic rock at Horseshoe Bend bridge consists of augite, hypersthene, and a little biotite, in part showing crystallographic outlines embedded in a clear feldspar mass consisting of short prisms of labradorite.

The small diorite area a mile northeast of Horseshoe Bend Bridge is a dark, coarse-granular rock consisting of biotite and hornblende with prismatic labradorite. The ill-defined area at the mouth of Porter Creek Canyon consists largely of a medium-grained quartz-diorite. Dikes and masses of diorite-porphyrite occur in it, and the diorite itself has a tendency to porphyritic structure.

Dike rocks.—The granite of the Boise quadrangle is cut by a great number of dikes of different kinds, but not many could be shown on the sheet. While there are a few dikes of basalt and rhyolite, the majority are of a holocrystalline type and probably were injected into the granite a comparatively short time after its consolidation.

Dikes of pegmatite — coarse-grained mixtures of orthoclase, quartz, and muscovite — are very common except in the more basic portion of the granite area, from the Willow Creek district up across the Payette. (*Dikes of pegmatite and granite-porphyry.*) Many pegmatite dikes are found east of Boise. They are especially abundant about the head waters of Shafer Creek, on both sides of the Healy toll road.

Dikes of granite-porphyry, some of them with a width as great as 100 feet, are of common occurrence in many parts of the quadrangle, but have not been indicated on the map. The rock has a yellowish-gray color, small porphyritic crystals of quartz and feldspar, and a usually micropegmatitic groundmass.

Dikes of quartz-hornblende-porphyrite are likewise abundant in certain sections of the quadrangle. The rock is ordinarily of a greenish-gray color, and prominently porphyritic by large white andesine or labradorite crystals, up to 10 mm. long, more rarely by quartz crystals. (*Dikes of quartz-hornblende-porphyrite and of lamprophyre.*) There are usually, also, smaller well-defined prisms of dark-green hornblende and foils of dark-brown biotite, all embedded in a reddish or grayish microcrystalline groundmass of quartz and unstriated feldspar. This type of intrusive rock is of widespread occurrence in Montana and Colorado. In the southern part of the granite area this variety is not common. Dikes of it begin to appear near Shafer Butte and are scattered along the eastern boundary. One or two occur along Hawkins toll road. A considerable area, continuing from the Idaho Basin quadrangle, is noted near the Ebenezer and Belzazzar veins, and many dikes of the same material cut the granite along the Jerusalem road where it crosses Boise Ridge. The largest area is that extending from near Horseshoe Bend to Crown Point Hill, and following the line of the quartz veins of Willow Creek and Rock Creek. On both sides of this area and in the upper Willow Creek Basin, southwest from Crown Point, a great number of smaller dikes of the same or similar rock occur. Where the large area crosses Rock Creek the type is somewhat different and is closely connected with the lamprophyric dike rocks, the rock being fine grained and dark green, with porphyritic labradorite prisms, augite, and a few black, shining crystals of hornblende.

Lamprophyric dike rock—fine-grained or porphyritic, dark, basic syenites and diorites—are not uncommon in the Idaho granite, and form narrow dikes which very often follow or lie parallel to quartz veins. In this quadrangle these rocks, in their typical development, have been noted in only a few places. A dark-green rock of this kind from the Scorpion tunnel, 5 miles east-northeast of Boise, consists of biotite, orthoclase, and plagioclase, while another similar dike near the Golden Star vein, 1½ miles south of the Scorpion, consists principally of brown hornblende and orthoclase.

ROCKS OF NEOCENE AGE.

Payette formation.—The sandy deposits of the Payette epoch occupy about one-fourth of the quadrangle and underlie the more recent formations over the whole southwestern half. They are derived chiefly from the disintegrated granite of Boise Ridge and consist predominantly of light-gray arkose, granitic sands, and loose sandstones. The grains are angular or imperfectly rounded, and thus indicate rapid accumulation near their source.

Extent and character of the Payette formation.

The high ridge along the southern boundary is composed entirely of coarse gravels alternating with sand. Even as far as 15 miles from the southeastern corner the gravels are coarse, the cobbles often attaining a diameter of 10 inches and consisting chiefly of hard granite-porphyries and allied rocks. These accumulations, deposited near the mouth of the Neocene Boise River, attain, near the bend of the present river, a depth of 700 feet, and overlie the sharply sloping granite to an elevation of 4100 feet. Near the river level occurs some basalt and tuff. A similar but smaller gravel mass lies on the opposite side of the river and attains an elevation of 4000 feet, 1100 feet above the present river level.

The formation is well exposed between Table Rock and Dry Creek, attaining a visible thickness of 800 feet and reaching from the edge of the alluvium, which has an elevation of 2800 feet, up to a maximum elevation of 3800 feet. Borings have shown an additional thickness of at least 500 feet, giving a total near the shore of 1300 feet. Along the sharply incised gulches the formation is plainly shown to rest against the abrupt granitic slope of Boise Ridge. A slight dip away from the mountains or to the northwest is noted in the hills between Dry Creek and the Boise. The formation appears as light-gray or yellowish, flat-topped, barren sand hills with occasional clayey beds and with a fairly distinct stratification. The sand is ordinarily only loosely cemented, though firmer sandstones occur at Table Rock and east of Boise, as described later under the heading "Building stones." Excellent examples of false bedding cutting diagonally across the stratum were noted in the foothills a mile northeast of Boise.

Near Table Rock there are some gravels and conglomerates in the series. At the base lie alternating strata of coarse and fine, loose granitic sand and gravelly beds. Above, the beds are chiefly sandy, alternately loosely and firmly consolidated. North of Table Rock and 200 feet below the summit, lies a firmly consolidated stratum of sandy coarse gravel, the cobbles reaching the diameter of a foot or more. The summit of Table Rock is one continuous stratum of hard sandstone with very distinct lines of stratification and vertical jointing. The lower strata of sandstone are not continuous, but change in places to loosely consolidated material.

As noted later under the heading "Springs and artesian wells," considerable masses of clay, basalt, and red basaltic tuff are found in the Payette formation below the surface near Boise. Near the contact with the granite small amounts of shore gravels are found. The occurrence of basalt tuffs and rhyolite interbedded in the series is mentioned under their respective headings. A small outcrop of gently inclined, loose sandstone with imperfect impressions of leaves was noted at the foot of the gravel bluff across the river from Boise. This exposure may also belong to the Payette formation.

The large area extending from Dry Creek to the northwestern boundary is, on the whole, of very uniform character. The strata are light gray, consisting chiefly of loose granitic sandstones, and form flat-topped hills cut up by many dry gulches, veritable pictures of desolation. That the same strata underlie the Pleistocene is shown by the Moore & Ballantyne well, 3 miles northeast of Star post-office, which is bored through 35 feet of Pleistocene gravels and 600 feet of underlying sandstones and sands with streaks of clay. Basalt flows lie intercalated in the series north of Dry Creek, and rhyolite near its base on South Fork of Willow Creek. A gentle dip of from 1° to 5° SW., W., or NW. is to be observed at many places. Thin strata of a compact white limestone occur north of Dry Creek, and on the point between the north and south forks of Willow Creek there is a layer of oolitic limestone.

Details of the Payette exposures.

A bluff of hard sandstone caps the rhyolite on the north side of South Willow Creek. On the south side of Payette Valley, at the western boundary of the quadrangle, is an excellent exposure, the bluff being 800 feet high. Its lower part consists of coarse granitic sand with occasional small pebbles of porphyry. In the upper part the sand is finer; there is a little more clayey material in small streaks, and one 6-inch seam of coaly material was noted. One mile southwest of Marsh the beds, several hundred feet thick, rest on basalt and contain abundant, largely basaltic gravels and tuffaceous strata. Near the mouth of Payette Canyon and south of the river several sheets of basalt are intercalated in the soft sandstones. The latter contain minor strata of clay and gravels. In the gravels basaltic pebbles occur, but are not so abundant as would be expected. The small area of coarse sandstone and gravel on top of the hill 4 miles west of Marsh contains mostly pebbles of quartz-porphyry, but also some of black vesicular basalt.

Similar soft sandstones of granitic origin, dipping gently westward, overlie the basalt flows of Squaw Butte, north of the Payette. The high hill just north of the Payette is capped by a few hundred feet of coarse and fine, hard sandstone. The strange fact that so little volcanic material is found among these deposits adjoining large volcanic areas has been emphasized in the description of the volcanic rocks, and appears to indicate that Squaw Butte had not attained its present height during the deposition of the Payette beds. It is also well to call attention to the fact that the large masses of gravel marking the mouth of the Neocene Boise River are here absent. It is doubtful whether Payette River existed during the early Neocene period.

Deposits of the intermontane valleys.

The Payette areas resting in the intermontane valleys are somewhat different from the main deposits in front of the range, and contain clay, tuffs, and coal beds; consequently evidences of plant life are better preserved than in the sandy beds. From strata near the coal was collected the flora upon which rests, in part, the evidence of the early Neocene age of the beds. The beds in the intermontane valleys are also often disturbed and uplifted.

North of Marsh the beds are sandy, with subordinate layers of brown clayey tuff. They appear to dip below the Squaw Butte basalt flows on the west and to be underlain by a basalt flow on the east. The dip is from 3° to 10° W.

Southwest of Marsh, accumulations of lake deposits lie on the steep granitic slope. The beds, which are often greatly disturbed, consist of sandstone, clay, thin coal seams, diatomaceous earth, fine gravels with basaltic pebbles, and brownish tuffs of volcanic glass, and are overlain by basalt. The beds are thus of somewhat earlier age than those on the west which cover the same basalts. From the clay of a coal prospect S. 40° E., and 2 miles from Marsh, numerous leaves were collected, consisting of Miocene species of oak, maple, magnolia, and sequoia. The beds here dip 50° SE.

The eastern end of this area consists, near Church placer mine, of fine auriferous gravels and white sands, slightly inclined westward. On the north the beds dip below Pleistocene gravels; on the south they are separated from the granite by the well-exposed vertical surface of a fault.

Exceptional elevation of the lake beds.

A long area of Payette lake beds extends nearly uninterruptedly across from the Willow Creek mining district to the northern boundary of the quadrangle. These beds were evidently deposited in a narrow bay or fiord of the lake, and the strata have undergone subsequent disturbance. In the vicinity of Prospect Peak the beds are sandy and clayey; the dip is not readily ascertained. They attain an elevation of 4800 feet, which is 500 feet more than the highest stand of the lake at the mouth of Boise River, and may indicate a local uplift. A little north of South Willow Creek, on the road from Boise to Pearl, tuffs and partly volcanic sandstones underlie the basalt. About the head of Rock Creek are rolling flats covered by sandy clay, with flat dip, and scattered basalt overlying it.

The area extending from the head of Rock Creek to Horseshoe Bend is interesting. It consists of a rapidly alternating series of light-colored clays and sandstones lying in a valley between high granite hills and resting on a very uneven surface.

Maximum thickness of the lake deposits.

Near the Rock Creek divide the rocks do not show clearly defined stratification. Stiff white clay, sand, and fine gravel are exposed and basaltic fragments are strewn over a large surface. There are also some distinct minor basalt flows, probably erupted from a vent near the summit during the deposition of the lake beds. The topography of the slope leading down to Horseshoe Bend is very confused; the lake beds are fairly well exposed, the sands and clayey beds dipping westward about 20°. A great number of little lake basins occur in the disturbed beds, and look at first glance much like crater lakes or "maars." In all probability they are produced by the continual small landslides in the soft, tilted strata with their interbedded small volcanic flows. Near Horseshoe Bend the strata are most disturbed, forming a monoclinal uplift, the direction of which is a few degrees east of north. The dip is generally from 15° to 25° W. Along the western contact at the foot of the granite ridge dips increasing to 80° are found. A total thickness of 1000 to 1200 feet of lake beds is exposed. On the eastern side the base of the formation rests on a rough surface of granite; a short distance above the granite are small coal seams, described later; above these, light-colored clay shale and sandstone alternate. A few plant impressions were found in the shale above the coal.

Strata of the Payette formation in all probability underlie the alluvium of Horseshoe Bend, and continue up to the boundary of the quadrangle on the north. The width of the area increases to 3 miles. The strata are inclined westward at angles of from 8° to 15°, and consist, as before, of light-colored, soft sandstones and clays or clay shales, forming rounded hills easily distinguished from the granite areas. Near some of the intrusive basalt dikes a metamorphism of the clays to a hard siliceous mass is noted; for instance, near the mouth of Jackass Canyon. At Brainard Creek, where extensive basalt flows underlie the formation, it is thin and consists of sand, clay, and fine gravel, but it is remarkable that hardly any volcanic fragments occur in the latter.

Small patches of lake beds lie in the little valleys and on the flat divides east of the main area, and reach a maximum elevation of 4500 feet. A peculiar species of the family of the Umbelliferæ grows abundantly and characteristically on the clayey lake beds. The largest of these areas is the one in the upper Shafer Creek Valley. It consists of a series of well-consolidated sands and clay shales of marked fissility, all dipping northwest, west, or southwest at angles up to 25°. The top layer is an extremely coarse sandstone, difficult to distinguish from the adjoining granite, and reaches a maximum elevation of 4500 feet. In the clay shale one-fourth of a mile southwest of Cartwright, very fine impressions of leaves were obtained, identical with those collected near Marsh and at Horseshoe Bend. Among them are species of oak, maple, poplar, and sequoia.

Flora of the Payette formation.

The flora collected from the Payette formation has been obtained chiefly from the lower part of the series as exposed in the intermontane valleys, where the conditions for the formation of clayey beds were most favorable. It consists largely of deciduous trees, indicating a climate much milder than that of the present time, and exhibits a close relation to the flora of the John Day beds (Oregon), the Lamar flora of the Yellowstone National Park, and the flora of the auriferous gravels of the Sierra Nevada.

Payette lake.

A large part of the Pacific Slope was at this time dotted with more or less extensive fresh-water lakes. The Payette lake reached up the river valleys previously excavated, forming long fiords. It seems clear, also, that several closed basins, of minor extent and produced by movements of the earth's crust, existed within the mountainous area on the northeastern shore of the lake. Of such character probably were the depression of Spring Valley, 500 feet deep, and that of Shafer Creek. Horseshoe Bend and Jerusalem valleys may also represent a once closed depression. In the southern part of the quadrangle the surface on which the Payette formation rests is clearly one of erosion, similar to the slope of Boise Ridge to-day.

The age and origin of Payette River.

The antiquity of Boise River, which antedates the lake beds, has already been referred to. In the Payette drainage the geological history is not so clearly read. The absence of large bodies of gravels in the lake beds at the mouth of Payette River has already been noted. It suggests that this river was not outlined in its present form, like the Boise, before the Neocene period. If this be so, orogenic changes of great importance have certainly taken place in the Payette watershed. However, a minor stream probably followed the lower course of the present river, for it appears likely that the Shafer Creek drainage was outlined before the Payette epoch and followed the present canyon down from Horseshoe Bend to Marsh Valley. If, as is probable, the basalt flows of Marsh Valley were erupted early in the Neocene period, Horseshoe Bend Valley must have been dammed by these during at least a part of the Payette epoch. It is also well within possibility that the valley in question is partly of tectonic origin—i. e. due to earth movements and caused by a local sinking between fault planes. The full history of Payette River can not be told with the data now available. Neither, it must be confessed, are the data sufficient for a detailed discussion of the cause and mechanics of the disturbances that the formation has undergone since the Payette epoch. The slight dips often noted in the lake beds may to a great extent be initial dips, caused by deposition on a sharply sloping surface. Disturbances are, however, clearly indicated in the Squaw Butte, the Horseshoe Bend, and the Shafer Creek areas. Monoclinal uplifts, the strata all dipping westward, are the result of orogenic movements which probably involved both horizontal and vertical forces.

Two localities of rhyolite eruption.

Rhyolite.—Limited eruptions of rhyolite took place during the earlier part of the Payette lacustrine epoch, and now underlie the sandy beds near Boise and between the head waters of the two forks of Willow Creek. The first locality is well exposed 3 miles east of Boise along the Idaho City toll road, where Cottonwood Creek has cut an abrupt canyon through the volcanic flow. The rhyolite covers about 180 acres. The eastern part is massive, grayish brown, and has a vertical lamination, while a distinct flow structure is apparent on close inspection. On the northeastern side it borders directly against the granite, and its point of eruption is doubtless located here. The rock is a lithoidal rhyolite containing small scattered crystals of feldspar, quartz, and tridymite. The prevailing mass is microspherulitic, while other specimens show a perlitic glass with streams of trichites. On the western side the rock becomes glassy and tuffaceous and dips below the Payette sandstones. A small dike of greenish-gray, flinty rhyolite occurs in granite in Stuart Gulch at an elevation of 3300 feet and contains orthoclase, plagioclase, and corroded quartz crystals in a glassy trichitic groundmass.

At the second principal locality the centers of eruption are found on the summit of the ridge extending west from Prospect Peak. The rhyolite occupies about 4 square miles, chiefly on the slope toward South Fork of Willow Creek, along the bed of which the flow may be seen to border against granite on the east and to be overlain by the Payette sandstone on the west. The flow is here about 150 feet thick, but a greater thickness is reached a little farther north upon the slope. There are two distinctly recognizable vents along the summit of the ridge, marked by sharp peaks of laminated rhyolite. The first is Prospect Peak, from which a flow of massive rhyolite extends a mile down toward the southeast. The second is a conical peak of equal height a mile west of Prospect Peak. From this vent the flow extends toward the south, characterized by rough, reddish-brown, extremely rocky ridges. A smaller flow runs northwest from a point midway between the two principal vents and reaches nearly down to Pearl. It is probable that the flows extend westward for a considerable distance below the Payette sandstones. Bowlders and pebbles of rhyolite are very common on the summits of the ridge 2 miles southeast of Aikman's, while streaks of rhyolite tuff occur in sandstone on the ridges between the two forks of Willow Creek near Aikman's ranch. The rock is generally a reddish-brown, lithoidal rhyolite with fluidal structure, containing small crystals of feldspar, quartz, and tridymite in a brownish microspherulitic groundmass. Pink and white tuff and rhyolite glass occur in the flow near Pearl. In South Willow Creek a dark-brown or red jaspery rock occurs in close relation to the rhyolite. It takes a good polish and is often erroneously referred to as onyx.

Sandstones containing rhyolitic glass were found in the Payette formation 2 miles southeast of Marsh. Pebbles of obsidian were noted in the tuffaceous sandstones in basalt 2 miles west of Squaw Creek, near the northern boundary line.

Andesite.—Rocks of the composition of normal andesites are rare in this quadrangle, though some of the basalts are somewhat related to this group. The only rock closely related to the andesites is that forming a small intrusive mass in the Payette sandstone one-fourth mile northwest of the penitentiary at Boise. Being a very small area and the only one of the kind, it is indicated on the map by the same color and pattern as the basalt. At this interesting locality, well visible from near the Natatorium, the intrusive mass appears as a knob a few hundred feet long and 150 feet high, covered by an arched stratum of sandstone, very clearly uplifted by the force of the intrusion. In the cut at the hot-water reservoir the sandy strata near the contact are seen to be locally disturbed, dipping southeasterly at a steep angle. This intrusive appears to form a laccolith in miniature. The rock is dark and glassy, not holocrystalline, as would be expected, and consists of small porphyritic soda-lime feldspars (andesine) and small augite crystals in a brownish perlitic glass with many feldspar microlites.

Laccolithic intrusion of andesite.

Early Neocene basalt.—Extensive basaltic eruptions took place during the deposition of the Payette formation, especially in the northern part of the quadrangle. The eruptions consist in part of flows and associated tuffs intercalated in the Payette beds, in part of necks and dikes breaking through the same and metamorphosing the immediately adjoining sediments. Though almost all types of feldspar basalt are present, one can not fail to be struck with the prevalence of coarse, holocrystalline structures, closely approaching diabase, to which the name dolerite is applied. Most of these basaltic eruptions appear to have taken place near the shore line of the Miocene lake. They are later than the rhyolite, and the majority of the eruptions probably occurred during the early part of the Payette epoch.

Character of the early basalt.

Reddish-brown tuffs and massive basalts lie at the base of the Payette gravels on the south side of the great bend of Boise River. Similar rocks also outcrop at six places in the Payette area north of the bend. The rock is medium grained and vesicular, consisting of lathlike labradorite, brownish augite, and reddish-brown olivine (iddingsite). Between the grains lies a little dark glass.

Between Table Rock and Dry Creek are also many exposures. An old narrow flow, the direction of which indicates a drainage different from the present one, originated $4\frac{1}{2}$ miles east of Boise and extended down toward Hot Springs. It is probably the same flow which appears again at Hot Springs below the sandstones in a few small patches. The rock is a very fine grained, vesicular, normal feldspar basalt. Reddish-brown basalt tuffs, consisting of dark-brown glass fragments and ranging from 20 to 100 feet thick, appear in many places along the contact of the Payette sandstone with the granite from Table Rock to Dry Creek. These strata dip westward at angles up to 10°. The same tuff outcrops on the hill south of the Idaho City toll road 3 miles east of Boise. A small, probably intrusive, mass of doleritic basalt lies in the sandstones at the mouth of Cottonwood Creek near the army post. Nearly all of the artesian wells bored in Hulls Gulch, on the military reservation, and at the penitentiary, have encountered masses of basalt. At Hulls Gulch a basalt flow 40 feet thick lies 400 feet, or somewhat more, below the surface, while in the reservation wells 70 to 100 feet of basalt has been found, the upper contact having a depth of 130 to 160 feet. Below the basalt flow lie heavy beds of red basaltic tuff of clayey character.

Remnants of early basalt flows.

On the north side of Dry Creek is a well-defined flow, several hundred feet thick in its northern part, and gradually thinning out, with transitions into tuffs where it underlies the Payette sandstone. The basalt is very vesicular, the cavities being often filled by zeolites, notably chabazite. Near the center of the flow the basalt is more compact and has a holocrystalline diabasic structure. At the base of the flow lie about 100 feet of brick red to brown tuffs. The dip is 10°–20° W.

One mile northeast of Schicks are excellent exposures of thin flows of compact granular dolerite, almost free from glass, embedded in the lake beds. The lower flow is 15 feet thick; the upper one, 20 feet. They are separated by 40 feet of partly cemented coarse sand, and are covered by 80 feet of the same material. Brownish tuffs belonging to the same flow occur a short distance east of Schicks. A similar intercalated flow occurs on the north side of Spring Valley Creek. The long area of compact black basalt along the Healy toll road, which has flowed north and south from a vent near the summit, is probably also of early Neocene age.

The areas near Cartwright belong to the same period of eruption. The more northerly area is a flow originating in the granite and apparently overlying the sandstone. The southerly flow also had a vent in the granite, but may dip below the sandstones, and has the appearance of having been tilted together with the sandstones.

A great number of basalt areas are contained in the Payette formation of Horseshoe Bend and Jerusalem valleys. Many of them are distinct flows intercalated in that formation, but others are dikes or necks breaking through the beds and metamorphosing the adjoining sediments. A distinct flow originated in a small vent a short distance west of Prospect Peak and extended down to South Willow Creek. South of Horseshoe Bend are a great number of small areas, and basalt fragments are widely scattered. Some of the areas clearly represent small flows, while others may be either flows or dikes. The basalt lying on the mountain slope and reaching down to Shafer Creek is clearly a flow poured out from a vent still indicated by a small craterlike depression at the highest point of the area. As it rests on granite over the larger part of the slope, its eruption must have occurred either in the early part of the lake epoch, before the valley was filled with sediments, or after a larger part of them had been removed by erosion. The former is the more probable alternative, for the flow does not show evidence of recent origin, as the late Neocene Snake River basalts do. The exposures at its junction with the sandstone at the base of the hill are not good. The rock is a normal glassy olivine-basalt, and contains many geodes of chalcedony and quartz. The smaller area 1500 feet east of the post-office is probably a local eruption, as metamorphosed silicified shale occurs close to it. A large fossil tree stump was noted at the edge of this basalt area.

Basalt in the vicinity of Horseshoe Bend.

The smaller areas near the mouth of Jackass Canyon are probably local eruptives, as metamorphosed shale is found in the vicinity. In Jerusalem Valley are many basalt areas, the chief vents of eruption being located along the east margin of the Payette area.

On the summit of Boise Ridge, in the northeastern corner of the quadrangle, rests a series of basalts and tuffs connecting with the large area in Brainard Creek. At the base lies 300 feet of massive basalt, followed by 200 feet of tuffs and scoriaceous basalt and capped by 100 feet of fresh black basalt. A small mass of well-washed auriferous gravel, the origin of which is difficult to explain, occurs on the summit of the ridge a mile south of the northern boundary line. The basalts on the north side of Brainard Creek are well exposed and probably once covered the whole of the southern side also. They consist of a great number of thin flows of usually vesicular rock, forming a continuous series, which is locally 800 feet thick and is overlain on the north side by the Payette sandstones. The dip of the flows is from 15° to 30° NNW., and is in some degree due to the original slope of the underlying rock, but it is clear that the flows have been still farther tilted toward the northwest, as has been the whole of the Payette formation in the valley. Smaller flows underlie the sandstone a short distance west of the coal prospect north of Brainard Creek.

On both sides of Porter Creek basalt borders against the granite, sometimes appearing as flows and again as dikelike masses. Eruptions certainly took place on the high granite peak north of Porter Creek and flowed down the side hill toward Brainard Creek. The long basalt area contained in the Payette formation near by, appears to be a dike, at least in its northern portion. The basalt is of the usual kind — black, fine to medium grained, and weathering brownish red. It sometimes contains large porphyritic labradorite crystals. Olivine is nearly always present. It has generally a distinct diabasic granular structure of varying grain. One of the coarsest and most holocrystalline rocks is found at the mouth of Porter Creek Canyon. In some of the flow rocks a little glass is also present, being pressed in between the grains of the principal constituents.

Large and deep flows of black, fine-grained, vesicular basalt, weathering brownish red, cover the hillside east of Squaw Creek, having been erupted near the summit, 2000 feet above the valley. At the base, near the Payette flow, tuffs underlie the flows. The flow probably dips below the Payette formation in Marsh Valley, which also contains some volcanic tuffs, but evidence upon this point is not conclusive.

Large flows near Marsh.

South of Marsh extends a large area of basalt which evidently had its point of eruption in the high granite hills between Marsh and Crown Point and flowed down over the steep hillsides toward the northeast and west. One mile southwest of Marsh the basalt is clearly overlain by Payette lake beds containing volcanic gravel and tuff. In fact, along the whole western contact it is clear that the igneous flows dip below the lake beds. Southwest of Marsh, on the other hand, the Payette formation is overlain by the same basalt, though, on account of the fractured, crumbling character of the basalt, satisfactory exposures are rare. Tuffs and volcanic pebbles occur in the lake beds. The basalt is vesicular, and breaks easily in small angular fragments, covering the hillsides with coal-black débris fans. The rock often contains porphyritic labradorite crystals and is a normal glassy olivine-basalt.

At the mouth of Payette River Canyon, 5 miles west of Marsh, are several sharply marked volcanic sheets, reaching 200 feet in thickness, embedded in the soft sandstones. The rock is a black, extremely fine-grained, glassy basalt, and the mass is probably composed of surface flows subsequently covered by granitic sand. Pebbles of basalt occur in the sandstones which cap it.

The large volcanic area of Squaw Butte is of particular interest. It forms a broad, rough ridge between Squaw Creek on the east and the flat Payette sandstones on the west, culminating just beyond the northern boundary of the Boise quadrangle at an elevation of 5800 feet. It is one of the landmarks of the lower Snake River Valley and is very prominent, its reddish-brown outcrops contrasting strongly with the light-colored sandstones. The ridge down to Payette River is made up almost exclusively of a succession of basaltic flows more or less strongly tilted and all dipping toward the west or northwest. Until the survey of that part of the area falling within the quadrangle adjoining on the north is finished the full history of this volcanic outburst can not be given, but it appears probable that after the eruptions an orogenic disturbance took place, producing a break along the eastern base of the butte and a westward tilting of the flows.

Squaw Butte.

The small butte across the river from Marsh consists of at least ten flows, from 5 to 250 feet thick, all dipping 20°–30° W. Vesicular and dense flows alternate. The top flow is 250 feet thick and consists of dolerite with granular structure. Other flows are more or less glassy. An inclusion of sandstone in basalt was noted near the top of this butte. On the west the basalt rests on granite, outcropping near the river bank, while on the north the sands and tuffs of the Payette formation appear to underlie it.

The basalts of the main area weather, as a rule, to a brownish-red color, and consist entirely of feldspar-olivine basalts, most of them vesicular, many even scoriaceous. Zeolites are sometimes found in the cavities. Basalts with some glass predominate, while others have a granular diabasic structure with a little glass wedged in between the grains. The total thickness of the flows appears to amount to many thousand feet. The estimate is qualified by a possibility of duplication by faulting. The individual sheets vary in thickness from 10 to 100 feet. As many as fifteen of these flows were counted at one place. The dip of the flows is always toward the southwest, west, or northwest, and ranges from 20° to 40°. The area is bounded on the south by the alluvium of Payette River, and on the south side of the river the flows have the appearance of dipping below the sandstones. On the east it borders against the Pleistocene terrace flanking Squaw Creek. Near the northern boundary line of the quadrangle there is an area of soft tuffs with volcanic gravels, intercalated in the volcanic series. On the west the basalts border against the Payette sandstones and, as far as can be seen, dip below them, forming a very uneven surface, upon which the Payette sandstones were deposited. A few small layers of tuff lie in the sandstone near the contact, but as a whole there is very little volcanic material in them, and even volcanic pebbles are remarkably rare. A few miles from the northwestern corner tuffs become abundant near the contact and alternate with sandstones. The strike here turns rapidly toward the northeast. At different places in the volcanic area a mile or two from the corner of the quadrangle smaller beds of pure granitic sands appear among the volcanic flows on the ridges at elevations of about 3500 feet. These sheets of sand, together with some tuffaceous beds, are clearly intercalated between the massive basalt flows. Westward the dip grows gradually less. In the high, rough central ridges the flows dip 30°–40° NW. A little farther westward, where the sands occur in the basalt, the dip is 20° W., while at the edge of the volcanic area it is 5°–10°.

Exceptional thickness of the Squaw Butte flows.

Squaw Butte is thus a Neocene basaltic volcano, built up of successive thin flows of massive rock, with a small amount of tuffs. The flows rest on granite or on the lower Payette sandstone beds, and are covered by the upper and larger division of the same sandstones. A dislocation has in all probability cut the eastern base of the volcano, producing a steep scarp of the broken volcanic strata. It must be regarded as very remarkable that volcanic detritus is so scarce in the Payette sandstones at the western base of the mountain. It probably indicates that the Butte was not uplifted by orogenic agencies until after the close of the Payette epoch.

A Neocene basaltic volcano.

Late Neocene (Pliocene) sediments.—In the Boise quadrangle the latter part of the Neocene period was characterized largely by erosion, not by sedimentation. The Payette lake was partly drained; the present courses of the two principal rivers were laid out, and active erosion removed great masses of sediments which previously filled the whole of the southwestern part of the quadrangle up to an elevation of about 4000 feet.

Temporary checks to the draining of the lake are recorded by high shore gravels or river terraces.

North of Payette Valley, and 300 feet above the river, is a terrace cut in the lake beds and covered with coarse volcanic gravel. The elevation is 2700 feet. On the map this area has been marked as a higher or upper mesa of Pleistocene age, it being in fact difficult to decide whether it belongs to the Neocene or to the Pleistocene period. Again, northeast of Boise, at elevations of 3100 feet, there are indications of another terrace, probably of Pliocene age, cut in the lake beds and covered with gravel. The best records of subsequent events are found along Boise River.

Early river terraces.

When erosion had finally cut down to its present level along that water course, the valley extended in a nearly westerly direction from the mouth of the canyon. During the intervals between the late Neocene basalt flows which filled Boise River, considerable accumulations of sand and gravel were deposited at and in front of the mouth of the canyon. These river gravels are now exposed below the flows, and reach a maximum depth of 200 feet in the basalt canyon of Boise River.

Late Neocene (*Pliocene*) *basalt.*—Repeated basaltic eruptions took place during the close of the Neocene period. The Payette beds had been deposited, the lake partly drained, and the rivers had cut down through the accumulated beds to their present levels. Then the basalt broke out through numerous vents and flooded Snake River Valley. When eruptions took place within the foothills or mountains, the molten rock followed the creeks and rivers to lower elevations. At least two basaltic flows followed the South Fork of Boise River down to the mouth of the canyon, and a third came down from upper Moore Creek. Of the lowest flow, which was of small volume and probably the earliest, there are a few patches left in this quadrangle, on the southern side of the river. It is 20 feet thick and its surface lies about 40 feet above the river near the eastern boundary, while it sinks to river level in the last exposure on the northern side of the river at the great bend. A few feet of gravel rests below it on granite, and basalt pebbles occur in places below it, showing that still earlier eruptions must have taken place higher up the river. The surfaces of another flow, 30 to 40 feet thick, attain an elevation of 100 to 120 feet above the river and are underlain by a considerable thickness of gravel. Extensive remnants of this flow, which probably came down from Moore Creek, occur on both sides of the river from the eastern boundary to the great bend. The highest and most voluminous flow, 50 to 75 feet thick, reached an elevation of 300 feet above the river, and is again underlain by a considerable thickness of gravel and sand. The top of the basalt patches left along the river is almost invariably covered by a sloping shelf of detritus and sand, washed down over it from the granitic hills above. Between the time of the second and that of the third flow, the canyon near and beyond its mouth was filled by gravel and sand, reaching 250 feet above the present river level. Over this flood plain a local flow 75 feet thick poured out from a vent in the Payette gravels 2 miles southwest of the great bend in the river. It now forms the well-defined mesa to the south of the basalt canyon, and probably extended a few miles westward. A new shallow channel was then eroded in the basalt and underlying gravels, extending a little north of the river in the basalt canyon and thence in a nearly easterly direction. The last great eruption, mentioned above as the third flow, 300 feet above the river, then occurred, filling this channel and extending for 10 or 12 miles, as far down as Tenmile Creek. The relations of the older and younger flows are well shown on the south side of the river at the mouth of the basalt canyon. The basalt eruptions mark the close of the Neocene period.

Extent of the late basalt flows.

In the southwestern corner of the quadrangle there is still another large basalt area, the solid basalt outcropping in the creek along the railroad. This flow is, in all probability, not connected with the flows from Boise River, but belongs to an extensive area occupying parts of Nampa, Silver City, and Bisuka quadrangles, and appears to have issued from vents in the northwestern part of the last-named area.

The basalt flows, when bare, present a rough surface of black rock almost entirely unaffected by decomposition. A little eolian sand is generally scattered over the higher parts; for instance, south of the Boise basalt canyon. Near the Payette gravel ridges, along the southern boundary, alluvial wash covers it. The western parts of the Boise flow and the area in the southwestern corner are covered with fine shallow loam, like that of the Pleistocene mesas. Abundant angular basalt fragments are usually found on the surface.

Character and composition of the late basalt.

An abrupt scarp 20 to 75 feet high marks the line between the Boise basalt flow and the Pleistocene mesa to the north. Along the river the basalt presents nearly perpendicular cliffs. The flow is often divided by one or more horizontal partings. Excellent columnar structure is very common. Sometimes there are an upper flow and a lower flow of solid basalt, separated by a layer of rock easily crumbling into angular fragments.

The basalt is a black, dense rock, usually very vesicular and rarely showing olivine and feldspar crystals; it is a normal feldspar basalt, consisting of feldspar laths, augite crystals, and magnetite, with a little olivine, closely crowded but separated by brownish glass.

PLEISTOCENE.

The eventful Neocene period closed with the outpouring of the basalts. Boise River immediately began eroding a canyon in the flows which dammed it, and during the Pleistocene period its direction gradually swung northward, until it now runs parallel to and not far from the lake beds of the foothills. The basalt flows once eroded, further deepening of the valley proceeded very slowly, and was sometimes wholly checked. The history of the Pleistocene period may be divided into three long epochs, during which two broad river terraces were deposited in the open valley that had been carved from the Payette beds during the early Neocene. The two terraces may be referred to as the upper and lower Pleistocene mesas. The third stage is marked by the present broad alluvial valley. The two mesas are plains with a gentle northwesterly slope. Near the mouth of the canyon the lower mesa rises to a height of 50 feet above the river, the upper to 100 feet. Near the eastern boundary the lower is as much as 100 feet above and the upper 200 feet, the modern river thus having a steeper grade than its Pleistocene predecessor. The mesas are also somewhat developed on the northern side of the river, but are less characteristic. Their geological structure is similar, and is well exposed in the sharp bluffs which separate the alluvium from the lower mesa and in places divide the lower from the upper one.

Pleistocene mesas of the Boise Valley.

The underlying stratum always consists of 20 to 40 feet of heavy river gravel and is capped by 10 to 15 feet of extremely fine yellowish-gray sandy loam. Streaks of clayey sand sometimes appear in the gravel. Basalt pebbles occur in the gravels of both the upper and the lower mesa.

The alluvium of the present river bed consists chiefly of light granitic sand with some gravel and subordinate clay beds.

Along Payette River there is a well-defined terrace rising 100 feet above the river. Remnants of the same terrace are shown in Marsh Valley, Squaw Creek, Horseshoe Bend, and all the tributaries above. It consists, as usual, of a few feet of sandy loam or sand covering heavy gravel. On the northern side of Payette and Marsh valleys this gravel overlies the gently dipping sandstone or tuff of the lake bed. The latest formation is the sandy alluvium occupying wide areas in the Payette, Marsh, Squaw Creek, and Horseshoe Bend valleys.

Terraces along Payette River.

Nearly every creek in the quadrangle shows more or less plainly the influence of that temporary check of erosion to which the mesas owe their origin. The valley bottoms are generally filled by gravel and sand, through which recent erosion has cut a new channel.

ECONOMIC GEOLOGY.

GOLD.

AURIFEROUS GRAVELS.

Auriferous gravels of Pleistocene and Neocene age occur in many places in this quadrangle, though as a rule the deposits are neither extensive nor rich.

Neocene gravels.—The Payette formation described above occasionally contains gravel beds which have been worked for gold. Such gravels are exposed in several of the gulches a few miles east or northeast of Boise, where they have been worked on a small scale. The beds are exposed at the base of the formation, at the contact of the Payette sandstones with the underlying granite, and accumulated either as shore gravels or as stream gravels along the shore during the Payette epoch. Their gold was derived from the quartz veins which are abundant in this portion of Boise Ridge. The deposits are worked occasionally during the wet season. This gravel is found in Stewart Gulch, Dry Creek, Crane Gulch, and Curlew Gulch.

Gold in the Payette formation.

The large masses of coarse gravel of Neocene age which extend along the southern edge of the quadrangle contain a little gold, though not enough to be worked, even if water could be brought on them.

At Johnson's diggings, a mile and a half southwest of Marsh, there occurs, embedded in the Payette formation, a large amount of gravel, chiefly of volcanic rocks. All of these beds appear to contain some gold, probably derived from the vicinity of Crown Point Hill, where there are many quartz veins. By a second concentration the gold has accumulated in the gulches cutting through these gravels, and hydraulic washing has been conducted on a small scale for a long time along these small water courses. Very little water being available, the washing season is necessarily short. At Church's ranch, in the southeastern part of Marsh Valley, are sandy and clayey beds of the Payette formation which in one or two places contain bodies of quartz gravel. This gravel has been washed for gold, though at present the more extensive Pleistocene gravel beds in that vicinity are the only ones which are worked.

Remains of late Neocene (Pliocene) stream gravels are found under the basalt flows along Boise River near the bend of that river in the southeastern part of the quadrangle. As explained above, there are several flows, the lowest of which occurs at at an elevation of from 20 to 40 feet above the river, though only a few patches of this lowest flow are preserved. On the granite below this basalt rests a few feet of coarse, chiefly granitic gravel, which contains a considerable amount of coarse gold and which has been successfully worked at the Holy Terror mine, near the eastern boundary of the quadrangle, on the south side of the river; at the Charcoal mine, a little below the mouth of Charcoal ravine; and at Tarents, 2 miles farther down and also on the south side of the river. These deposits can be worked only in summer, as the high water in winter reaches or rises above the old bed-rock level. Below the three other basaltic flows heavier masses of gravel are found, in some places 20 and in a few places even 50 feet thick. These gravels have been prospected in a number of places and all contain fine gold, but they can not be worked except by the hydraulic method, and even then it is difficult to save the gold. The heaviest gravels of late Neocene age underlie the basalt flows in the narrow canyon 8 miles southeast of Boise. These gravels and sand masses are exposed by a number of tunnels run in under the basalt on both sides of the river. They also contain gold, and near the mouth of the canyon an attempt has been made to mine them by the hydraulic method. All of these late Neocene gravels are of fluviatile origin and were accumulated in the bed of Boise River before or during the basaltic eruptions.

Mines in Neocene stream gravel along Boise River.

Pleistocene gravels.—Pleistocene auriferous gravels are of common occurrence, but in a few places only are they of sufficient abundance and richness to be workable. The alluvial gravels of Boise River contain a little gold throughout, and the bars along the river have in former times yielded a considerable amount of gold. The same is true of Payette River. Fine gold occurs in the alluvial deposits along the river west of Marsh. A dredger was constructed a few miles below Marsh to work these alluvial gravels, but did not prove successful, on account of the very fine character of the gold. Gold is also found all through the gravels of the mesa in the southern part of Marsh Valley and at Church's ranch, and is probably derived from the quartz veins near Crown Point Hill. These Pleistocene alluvial gravels have been and still are worked on a small scale. The gravel is spread over a considerable area, but proves richest along certain channels representing the old course of the stream. The thickness of the gravel beds is slight, ordinarily amounting to only a few feet. The gold is coarse. A considerable area still remains to be washed. Alluvial benches have been worked along the north fork of Willow Creek up to a few miles below Pearl, and some work is still done there during the rainy season. A little gold occurs along Dry Creek, chiefly in the small alluvial terraces lining it at intervals. Rich placer deposits have been worked in Fall Creek, and to some extent also in Canyon Creek. They derive their gold from the belt of quartz veins occurring in that vicinity. Some gold is reported to have been washed from Shafer Creek near Cartwright's ranch. The creeks and ravines of the larger part of the granite area are practically barren.

Gold in Pleistocene gravel.

On the whole, the Neocene and Pleistocene gravel deposits along the minor water courses are traceable to the quartz veins of the Willow Creek district and to those on Boise Ridge east of Boise, while much of the gold along Boise and Payette rivers has been carried down from veins in the mountains to the east.

Derivation of the placer gold.

GOLD-BEARING VEINS.

A number of gold-quartz veins occur in the granite of Boise Ridge. Nearly all of them are fissure veins and have a direction ranging from E.-W. to WSW.-ENE.; the dip is either to the north or to the south. The age of these veins is certainly pre-Neocene and probably Cretaceous or Eocene. The ore carries its value principally in gold, though there is always some silver in the ore. A certain amount of free gold is generally present, but, as a rule, the larger part of the value is contained in the sulphurets and can not be easily extracted by simple amalgamation. The water level stands near the surface and fresh sulphides are found at slight depth. The principal mining districts are the Black Hornet, the Shaw Mountain, the Willow Creek, the Rock Creek, and the Quartzburg. The most active work is at present progressing in the Willow Creek and the Rock Creek districts.

Character of the gold ore.

The Neal mining district lies just outside of the Boise quadrangle, in the Idaho Basin quadrangle, 2 miles from the boundary line separating the two and near their southern common corner. Several prospects are found on the slope toward Boise River from the Neal district. Other slightly developed prospects on gold-quartz veins have been opened on the north side of Boise River, and in fact all the way up toward Lucky Peak. The Black Hornet vein is located a mile south-southeast of Lucky Peak. Its direction is northwesterly and the dip is toward the southwest. It is a wide vein, carrying much quartz, in which are embedded iron pyrite, zinc blende, arsenopyrite, and a little galena. It carries very little free gold. A long vein, upon which are located the Montana claim and others not so well known, extends in a northerly direction on the western side of Lucky Peak and has been developed by short tunnels and shafts. On the western and southwestern slopes of Lucky Peak are a great number of prospects more or less developed. Some of them are well-defined fissure veins; others, as the prospects 3 miles southwest of the Peak, are large bodies of mineralized quartz-porphyry. Some of the veins carry a quartz filling, while others are only marked by a streak of altered granite.

The Black Hornet vein.

On both sides of the Idaho City toll road east of Boise prospects are very abundant. The veins generally strike E.-W. Five miles east of Boise is the Golden Star group, where a small mill has been erected and some good ore taken out. A number of veins, one of them—the Scorpion—carrying heavy bodies of quartz, cross Fivemile Creek half a mile north of the toll road. The dip of the veins is to the south; they have been developed to only a small extent. One mile higher up on the same creek are the Blizzard and Tornado claims, which have produced some rich sulphide ore. Several prospects are found near the summit of Boise Ridge where the toll road crosses it. A short distance eastward, at Shaw Mountain, a long and well-defined quartz vein outcrops, upon which are located the Rising Sun and the Pay-

The Golden Star group.

Shaw Mountain mining district.

master mines, which together have yielded a considerable amount of gold. These veins all dip to the south and contain, besides free gold, pyrite, arsenopyrite, and zinc blende. Several smaller quartz veins outcrop south of the Rising Sun.

The central granite area culminating in Shafer Butte is remarkably barren of mineral deposits, and in but few of the gulches has any placer ground been found. It is probable that several veins occur in the upper drainage of Dry Creek, as placer gold has been found all along that stream. Near the eastern boundary line, in Dagget Creek, veins have been prospected for both gold and silver.

A short distance west of the Healy toll road, where it descends from the pass into the Shafer Creek drainage, a number of quartz veins have been prospected. In the same vicinity are many veins of coarse pegmatite, consisting of quartz and feldspar. Some of these also have been prospected, but do not appear to contain any gold. In the southwestern corner of the Shafer Creek area of lake beds the uppermost strata consist of a very coarse sandstone washed from the surrounding hills. This sandstone is in places impregnated with pyrite in an irregular manner, and several tunnels have been driven in this material, which is said to carry some gold.

Along the Hawkins toll road and in the rugged mountains north of it but few quartz veins have thus far been found; but as the country is accessible only with difficulty and is overgrown with brush, it can not be said to have been thoroughly prospected.

The Quartzburg gold belt.

The western end of the extensive Quartzburg gold belt falls within the limits of this quadrangle. At the very boundary, 4 miles south of the northeastern corner, lies the Newburg claim, a large body of a fractured and impregnated porphyry. On the divide between Fall Creek and Canyon Creek this is continued by the Belzazzar, Mountain Chief, and Ebenezer claims, all of which contain quartz veins in a sheeted zone of granite. Much gold has been washed from the surface material covering the veins. In depth the sulphides are much more abundant than on the surface.

Willow Creek district.

The Willow Creek and Rock Creek districts are marked by numerous veins, few of which can be traced for a long distance. Nearly all of them have a northeasterly strike, and dip at moderate angles to the north. The belt extends from the vicinity of the Lincoln mine, a mile west of Pearl, for 6 or 7 miles toward Horseshoe Bend. Dikes of hornblende-porphyrite accompany this vein system, but by no means all of the veins lie in porphyry or on the contact between granite and porphyry. The veins in both districts carry comparatively little free gold except on the surface, the larger part of the value being contained in the sulphurets, which consist of pyrite, zinc blende, arsenopyrite, and galena. There is, as a rule, but little quartz and calcite. In the Willow Creek district the veins are narrow and rich and are accompanied by a streak of altered and bleached granite a few feet in width. In the Rock Creek district the veins are, on the whole, wider, but frequently of lower grade. The veins upon which most work has been done are as follows:

South of Willow Creek, near Pearl, is the Checkmate, which from a small vein has produced a relatively large amount; also the Leviathan, the Friday, and the Lincoln, all of these lying in granite. On the north side of Willow Creek lie the Easter and the Judas, the latter developed by a shaft 400 feet deep. These veins are continued up toward Crown Point by a number of others on which less development work has been done. On the slope toward Rock Creek, a quarter of a mile east from Crown Point, lies the IXL, developed by a shaft 300 feet deep, and showing a considerable body of medium-grade ore. The claims on the Rock Creek side are less developed. In Rock Creek are located the Black Crook and the Blue Bucket, the first on the contact between granite and porphyry, the second one-half mile farther down in dioritic granite. The whole hillside sloping toward Payette River, east of Rock Creek, is covered by claims, and a considerable number of good veins carrying free gold on the surface have been exposed.

On the north side of the river, 3 miles east of Horseshoe Bend, is the Bodie claim. This is a wide dike of porphyry, evidently an offshoot from the mass of dark diorite on the east. It is mineralized to a considerable extent and probably contains some gold throughout.

Those ores which contain a certain amount of free gold are amalgamated and concentrated in small mills. The richer ore, exceeding $25 per ton, is generally shipped directly to the smelters. The lower-grade ores, not free milling, are not utilized at present on account of the lack of facilities for reduction.

SILVER VEINS.

Fissure veins carrying silver occur at different places in the granite, though at no place do they appear to be extensive and rich enough to be profitably worked. Prospects containing silver have been noted near the Idaho City toll road 3 or 4 miles east of Boise, on the head waters of Dry Creek a few miles southwest of Shafer Butte, 1 mile south of Church placer mine in Marsh Valley, 1½ miles north of Horseshoe Bend bridge on the western side of the river, near the mouth of Porter Creek Canyon, and finally also on the western side of the river one-half mile south of the northern boundary line. The silver veins generally contain a quartz gangue with a little galena and chalcopyrite or other copper minerals, together with tetrahedrite and other rich silver minerals. A vein carrying its principal value in silver lies a short distance south of the Mountain Chief in the Quartzburg district. Many of the Rock Creek and Willow Creek ores, such as the ore of the Lincoln vein, carry at least one-half of their value in silver.

DEPOSITS IN NEOCENE VOLCANIC ROCKS.

Traces of gold and silver have been found in altered Neocene rhyolite a few miles east of Boise and in altered andesite near the penitentiary. It is thus certain that a recurrence of mineralization accompanied the Neocene eruptions, though it is not believed that it produced any important deposits in this area.

QUICKSILVER.

Fragments of cinnabar occur in the gravels of the Church placer mine, and are found in the sluice boxes used for concentrating the gold. It is said to have been found in place in small seams in the granite of the vicinity.

IRON.

So far as known, iron ores do not exist in workable quantity in this quadrangle. Abundant loose fragments of magnetite occur in the gravels at Church placer mine, Marsh Valley, and in one of these pieces native gold has been found. A mass of heavy "iron rock" is doubtfully reported as occurring at the head of one of the northern branches of Porter Creek. A ledge of granitic rock containing abundant grains of magnetite and epidote, which is said also to carry some gold, was noted near the head of Clear Creek, 2 miles southeast of Shafer Butte.

LIMESTONE.

Limestone is found in a few places in the Payette formation. Near the summit of the ridge 1½ miles north of the Dry Creek schoolhouse a thin stratum of white compact limestone was noted. On the point between the north and south forks of Willow Creek there is a stratum of yellowish-gray oolitic limestone, several feet thick, which is locally used as building stone. It consists almost exclusively of concentric spheroids of calcite about 1 mm. in diameter, sometimes with small particles of foreign substances in the center. On or near the late Neocene basalt flows along the southern boundary crusts of cream-colored lime tufa, a few inches thick, frequently occur in the soil.

COAL.

Coal in the Payette formation.

The Payette formation contains in a few places coal beds which may prove of some economic importance. Traces of lignite are found in many places, such as 2 miles east of Boise in Cottonwood Creek, near Cartwright's ranch at Shafer Creek, in Marsh Valley, and other localities. The large area of Payette beds along the western boundary line carries, so far as known, no coal. In Marsh Valley thin seams of lignite have been found 2¼ miles southeast of Marsh post-office, at an elevation of 3000 feet, and 1¼ miles southwest of the same place at an elevation of 2800 feet. Still another coal prospect occurs near the head of Cottonwood Creek, 5 miles south of Horseshoe Bend post-office, a short distance west of the road to Boise.

Important coal prospect at Horseshoe Bend.

The only places where coal has been found in sufficient amount to warrant further prospecting are in Horseshoe Bend and Jerusalem valleys. At Horseshoe Bend the coal occurs on the eastern side of the valley, near the base of the formation, the beds of which here dip to the west. The principal development shown is at Robb's prospect, a mile south of Horseshoe Bend post-office. At this point, which has an elevation of 2750 feet, a tunnel with a total length of 220 feet is driven in a westerly direction. For the first 80 feet the tunnel passes through Pleistocene material; for the remaining distance it is in clay and clay shales containing coal seams. According to the section, there are two seams, the lower of which is 6 inches thick and consists of lignitic coal of poor quality. The second bed, separated from the first by 6 feet of clay, is 12 inches in thickness. The strata dip 20° W. and strike N. 10° W. At the end of the tunnel they are interrupted by a fault, the faulting plane having an inclination of 50° SW. and striking N. 40° W. The vertical throw is about 6 feet. The coal is compact, black, and shows brilliant luster and conchoidal fracture. The streak is black. It has no coking quality. The composition set forth in the following analysis indicates that it is a bituminous coal of medium quality:

Analysis of coal from Horseshoe Bend Valley.

Locality.	Moisture.	Volatile matter.	Fixed carbon.	Ash.
Robb's claim..............	4.84	36.23	54.55	4.38
"Horseshoe Bend"......	6.82	82.22		11.96

This coal seam probably continues below a part of the Horseshoe Bend Valley. Its profitable exploitation, owing to its small thickness, seems doubtful. The coal-bearing area is probably only 2 or 3 square miles in extent. At Hannafan's ranch, 2 miles northeast of Horseshoe Bend post-office, a prospect shaft near the river bank is said to have exposed some good coal. The shaft is not now, however, accessible.

Coal opening on Brainard Creek.

Over the large area of the Payette formation in the southern part of Jerusalem Valley there are no surface indications of coal, though seams of it may lie at the imperfectly exposed base of the series; but on the northern branch of Brainard Creek, 1 mile south of the northern boundary line, at Peterson's ranch, a short tunnel at the creek level has exposed a coal bed reaching 3 feet in thickness. The developments are not extensive enough to determine the value of this find, but the coal-bearing area probably does not exceed a square mile. The composition of this coal is given below. It is similar to the Horseshoe Bend coal, compact, and of fair quality. It has no coking qualities.

Analysis of coal from Jerusalem Valley.

Locality.	Moisture.	Volatile matter.	Fixed carbon.	Ash.
Peterson's claim, Jerusalem Valley.............	9.03	53.81	30.83	6.33

ABRASIVE MATERIAL.

Diatomaceous earth.

Beds of diatomaceous earth were noted at two places in the Payette formation. One mile southeast of Marsh, along the road to Willow Creek, at an elevation of 3000 feet, a considerable mass of it occurs associated with sandstone and fine gravel. It contains many fossil leaves in a good state of preservation. The other locality is on the ridge 3½ miles southwest of Horseshoe Bend post-office. It is here associated with sandstone and clay, and occurs, as at the first locality, in heavy compact masses showing no stratification. The rock is extremely fine grained, soft but compact, of white or creamy color, and consists largely of siliceous, delicately ornamented envelopes of minute algæ. Small angular fragments of volcanic glass also occur in this rock. It is a good abrasive material, and can also be used for other purposes, as for packing around steam pipes, being a good nonconductor of heat, and for writing, like chalk, which it resembles.

BUILDING STONES.

Granite.—The granite is rarely available as a building stone, on account of its deep disintegration and the extensive joint systems traversing it. In some places, such as in the high bluffs south of Horseshoe Bend, it might be used, but the remoteness of the locality renders it of small value.

Table Rock sandstone.

Sandstone.—The sandstone of the Payette formation is by far the most important building stone and at several places is of excellent quality. Over the larger part of that formation the sandy sediments are loose and insufficiently consolidated. At all of the localities where good sandstone occurs the quality appears to be the result of the cementing action of hot siliceous springs on the sands. The principal locality near Boise is Table Rock, the sandstone occurring in the eroded hills of the Payette formation from the Hot Springs on the south to a point northeast of the Natatorium on the north. At Table Rock the facilities for quarrying are excellent, and many buildings at Boise are constructed of this material. There are two principal strata, 50 to 100 feet thick, one at the top of Table Rock, the other 400 or 500 feet below it, separated by less firmly cemented material. About 200 feet below the top stratum is another, chiefly developed near the Hot Springs, and of less extent. The quarrying has been done largely from the immense blocks sliding down the hillside. Other quarries have been opened near the penitentiary. The sandstone is of light-gray, yellowish, or red color. The best quality is found in the lower strata, as the top layers are often somewhat too coarse. The rock is easily dressed and is well adapted for building purposes. It is composed of closely packed angular quartz and feldspar grains, the latter being often filled with secondary mica. Foils of original biotite and muscovite also occur. There is little if any pyrite present. The rock is very porous, containing extremely little cementing material. Though well adapted to this dry climate, its durability and strength are not of the highest character.

Another and smaller, locally indurated bed of sandstone, about 40 feet thick, occurs in Curlew Gulch, 2 miles northeast of Boise, where quarries are opened on it. It is finer grained, is light gray, and consists of angular feldspar and quartz grains and small mica flakes, cemented by small quantities of brownish material, doubtless consisting chiefly of hydrous silica. Small dark-brown specks indicate the probable presence of a little pyrite. This sandstone is of a higher grade than most of that from Table Rock.

Near Horseshoe Bend there are strata of coarse arkose sandstone which may be to some extent available as building stone.

Valuable building stone at Table Mountain.

Another extensive stratum of hardened sandstone is found at the "Table Mountain" north of South Fork of Willow Creek, 2 miles east of Aikman's ranch. The sandstone appears in a steep bluff rising a hundred feet or more above the creek and extending for a distance of about 1½ miles. No quarries have yet been opened on it, the locality being distant from railroads. The rock is an arkose sandstone, varying from coarse to rather fine grained, light gray to reddish in color. It consists chiefly of angular or partly rounded quartz and feldspar grains cemented to an extremely compact and firm rock by abundant brownish opal. There is no pyrite. This appears to be an exceptionally fine building stone, and may become valuable when it can be cheaply transported. Again, at "Table Mountain," rising on the north side of Payette River, in the northwestern corner of the quadrangle, there are several strata of firm sandstone, embracing in all an area of somewhat less than a square mile. The rock is very similar to that of the Willow Creek Table Mountain, though hardly of so high grade. The top stratum is ordinarily a coarse arkose, while fine-grained sandstones occur below. Much of the cementing material here also consists of hydrous silica or opal.

BRICK CLAYS.

Brick clays are not very abundant in this region, owing to the prevalence of sandy deposits, but they occur in several places in the Payette formation. A brick clay of good quality is at present utilized near the mouth of Hull Gulch, a short distance north of Boise, where it occurs interstratified with sands. Similar clays also occur in Horseshoe Bend Valley and in Marsh Valley.

SOILS.

The granite of Boise Ridge is, as stated above, disintegrated to considerable depth, and the hills are generally covered by a coarse sandy soil, which, however, is not adapted to agriculture, partly on account of its coarse character and partly on account of the steepness of the slopes.

The Payette formation is, as a rule, of extremely sandy character and not well suited for agriculture. Many of the creeks running through this terrane contain, however, bottom lands which prove very fertile whenever water can be brought on them. The Pleistocene formation affords by far the best soils. The soil along the bottom lands of Boise River and that of the Payette are, though sandy and light colored, very well adapted for the growing of alfalfa and clover, cereals, and fruit. The soil covering the wide Pleistocene mesas on both sides of the Boise and on the north side of the Payette consists of light-colored loam, which, wherever water can be brought on it, proves very fertile and evidently is rich in potassium and phosphorus. This fine sandy loam is, at the depth of from 10 to 15 feet, underlain by coarse gravel, which insures perfect drainage. These mesa soils are the most important from an agricultural point of view, and occupy the whole of the area indicated as the upper mesa and the lower mesa. Some of the smaller valleys, such as those of Marsh, Squaw Creek, Horseshoe Bend, and Jerusalem, contain Pleistocene soils more or less admixed with decomposition products of adjoining basaltic areas, and are in consequence exceptionally rich. This applies especially to the alluvial soils in Jerusalem Valley, which, wherever water is available, produce extremely abundant crops. The Payette formation in Jerusalem Valley does not, as a rule, carry good soil, being too clayey and sandy. The eastern basalt area along the southern edge of the quadrangle is very scantily covered with soil and is not available for cultivation. The area in the southwestern corner carries a covering of fine loam, but it is not deep, fragments of basalt being common on the surface.

Good agricultural soils on the mesas.

SPRINGS AND ARTESIAN WELLS.

COLD SPRINGS.

In granite.—As may be expected from the high elevation and the sheeted character of the granite, Boise Ridge contains a considerable number of perennial springs. At lower elevations they are less abundant in the granite. From this statement must, however, be excepted the greatly fissured region extending from Pearl in a northeasterly direction toward Horseshoe Bend. Around Crown Point Hill, Rock Creek, and the canyon side east of Rock Creek, cold springs are extremely abundant and carry a considerable quantity of water. In all probability these springs bring to light the water from the melting snows of Boise Ridge. They thus indicate the presence of deep and continuous fissures.

Perennial springs in granite.

In the Payette formation.—Springs occur at various places in the Payette formation, but are not abundant. There are, however, certain water-carrying strata, one of which, for instance, outcrops with considerable persistency along the 3000-foot contour in the hills between Dry Creek and Boise Valley. The quantity of water is generally not large. A large spring occurs at the base of the hills a mile north of Dry Creek schoolhouse. In Spring Valley one-half mile west of Howell's ranch an exceptionally large spring rises in the Payette sandstone at an elevation of 3400 feet, 100 feet above the valley; the flow is probably not less than 60 gallons per minute. Several springs occur in Willow Creek Valley near Aikman's ranch, while on the whole the large area of Payette formation near the western boundary line is extremely dry. In the southern and western part of the Squaw Butte volcanic area strong springs are very common at elevations of about 3500 feet. This is somewhat surprising in view of the fact that the volcanic flows and strata have a strong westerly dip; the water must be derived from the high mountains 10 to 15 miles to the east.

COLD ARTESIAN WATERS.

In granite.—In view of the irregularity of the water-bearing joints and fissures in the granite, the chances are ordinarily against obtaining water by deep boring in that rock. However, a well has been drilled about one-third of a mile south of Church ranch, Marsh Valley, at an elevation of about 3000 feet, 500 feet above Marsh post-office. The well is 400 feet deep, bored through soft granite and some porphyry. It flows at least 10 or 15 gallons per minute.

On the plains.—In the Neocene and Pleistocene formations wells have been bored with widely differing results. Those in the large Pleistocene areas have not obtained flowing water. The Moore & Ballantyne well, elevation 2575 feet, on the first mesa, 3 miles northeast of Star post-office, is 667 feet deep. It traversed 35 feet of sand and bowlders (Pleistocene terrace), then 595 feet of sand with clay streaks (Payette formation), and at the bottom struck loose mud with leaves, fir cones, and fish bones, some of the fir cones being incrusted with pyrite. A large tree trunk was also bored through at this depth. Several small flows of water were struck. The water stands within 18 feet of the top. A well at Nampa, 3 miles southwest of where the railroad from Boise crosses the western boundary line, at an elevation of 2490 feet, had no better success. It traversed 60 feet of "hardpan sediment" (Pleistocene), 15 feet of basalt, below which roots and mold were found, then 240 feet of sand and clay (late Neocene), at 320 feet vegetable mold, and below this a harder sandstone, probably the Payette formation. Water was found at varying depths, and stands within 15 feet of the top.

The Moore & Ballantyne well.

At Foote's ranch, elevation 2815 feet, 3 miles southwest of Boise, on the second Pleistocene mesa, a well was bored to a depth of 630 feet, no flowing water being obtained except by pumping. Along the river no wells have been bored, as all the necessary water is easily obtained by means of canals.

In the Payette formation.—At Hulls Gulch, $1\frac{1}{2}$ miles north of Boise, several wells have struck artesian water which is now utilized for the municipal water supply. The elevation is about 2750 feet. The wells are bored in the thin alluvium in the bottom of the gulch. There are eight wells, 6 inches in diameter, close together, five of them 400 feet deep, and one reaching 619 feet. The wells flow from 40 to 250 gallons per minute, while the aggregate flow is stated to be about 670 gallons per minute. The water is cold and of good quality. The borings traverse, first, 200 feet of sand and sandstone, and then 200 feet of clayey beds, at the bottom of which the chief water-bearing stratum is struck in the form of a bed of sand. In the deepest well there are below the clay 40 feet of sand, 20 feet of clay, and 46 feet of solid lava, below which clay occurs again.

Wells at Hulls Gulch.

In the gulch next north of Hulls, on the Davis ranch, are two wells 150 feet deep with a maximum flow of 40 gallons per minute. A well bored to 400 feet in a small ravine south of Hulls Gulch found no water, traversing only clay in depth. The hot wells a little farther south will be described later.

A well was bored in the Payette formation one-quarter of a mile west-southwest of Howell's ranch, Spring Valley, at an elevation of 3300 feet, the level of the valley, to a depth of 500 feet through sandstone. At the bottom a layer of black vegetable mold was found. This well yields a flow of about 30 gallons per minute, the flow not diminishing that of the big spring previously noted, 100 feet above, in the same gulch.

This is, in brief, the record of the cold-water artesian wells thus far bored. So far as our present knowledge of the Snake River Valley extends, it would seem probable that it is a tectonic trough, and that the topographic conditions are favorable for artesian wells, especially in its lower part. Failure to obtain water in the wells bored is doubtless due to the sandy character of the strata and the absence of certain well-defined water-bearing layers. The question is not yet settled, however, because none of the wells have certainly penetrated the whole of the Payette formation, and near the base of it there may be clayey or tuffaceous beds, confining the water in better-defined layers. So far as is now known, the most favorable places for obtaining flowing water at moderate depth are near the mountains, places where the Payette formation rests in trough-shaped depressions, or where extensive clayey beds confine the water. Experience has shown that large flows can not be expected, but there are many places where it is reasonable to suppose that flowing wells might be bored. Among the most favorable localities are those where volcanic beds occur accompanied by clayey tuffs. Anomalous conditions exist in Spring Valley, indicating an irregular flow or a flow on fissures and crevices; for we have here a decided trough filled with Payette beds; a well penetrating to the bottom of these yields but a small amount, while higher up in the same ravine a very large amount of water issues from a spring. Among the probably favorable localities for flowing wells may be mentioned the upper part of the alluvial valleys of Dry Creek and Willow Creek, Marsh Valley, lower Squaw Creek Valley, lower Brainard Creek and Porter Creek valleys, and possibly Horseshoe Bend Valley. Artesian water might also be found in the smaller alluvial valleys at the western base of Squaw Butte, if the borings penetrated into the tuffs which here underlie the Payette sandstones.

Artesian water in Snake River Valley.

HOT SPRINGS.

The Boise hot springs issue from the sandstone of the Payette formation in a gulch near the edge of the alluvium, $4\frac{1}{2}$ miles southeast of Boise. There are several springs, the aggregate volume of which is not great. The temperature varies from 125° F. to near the boiling point. It is a relatively weak mineral water, with a faint smell of sulphureted hydrogen. While no analysis is available, its composition is probably very similar to that of the water from the artesian wells nearer the city. A tepid spring of small volume is seen in Cottonwood Creek about a mile from the city. Hot springs of considerable volume issue from the western bank of Squaw Creek 3 miles north of Boise. No analysis of this water is available.

HOT ARTESIAN WATERS.

Hot water has been found in deep borings at several places near Boise. The principal hot artesian wells are located about 200 feet north of the penitentiary, 2 miles southeast of Boise, in the alluvial ground at the very base of the bluff of Payette sandstone. There are three wells, with an aggregate flow of 800,000 gallons per day of twenty-four hours, or about 550 gallons per minute. The temperature of the water, which is piped to the city and extensively used for heating, etc., is 170° F. It contains a very slight amount of sulphureted hydrogen, and nearly 20 grains per gallon (about 300 parts per million) of solid constituents, of which one-half is carbonate of soda. The remainder is chiefly silica, in which the water is relatively rich, sulphate of sodium and potassium, chloride of sodium, and carbonate of lime. A little lithia is also said to be contained in it. It is thus a weak mineral water, coming well within the category of potable water. The three wells are respectively 394, 404, and 455 feet deep. Exact sections are not available, but it is stated that the upper part is bored in sandstone; then follow several sheets or dikes of basalt, below which a red volcanic tuff with much black sand was encountered. The first warm water was met at 120 feet, the temperature being 130° F. The largest flow occurred at 400 feet. The water is under moderate pressure and will rise not more than 50 feet above the mouth, which is at an elevation of nearly 2800 feet.

Analysis of the hot well water

Among the several wells drilled on the military reservation, a mile east of the city, at least two flow warm water. One is located one-half mile from the mouth of the canyon, on Cottonwood Gulch, at an elevation of 2850 feet. Near the starting point there was a small tepid spring. A total depth of 450 feet was attained, with some flowing water, the temperature steadily increasing from 75° to 140° F. A second well bored near by reached 482 feet and flows 70,000 gallons in twenty-four hours, the water having a temperature of 90° F. Both wells penetrated at first 130 to 160 feet of sandstone, then 72 to 116 feet of hard black lava, below which occurred a series 200 to 250 feet thick of sandstones, clays, and red basaltic tuffs rich in magnetite and sometimes also containing pyrite. The hot water does not extend over a wide area, as shown by a well bored in a gulch a short distance south of Cottonwood Gulch. This traversed 400 feet of sandy clay, below which basalt was found; no water was obtained.

The finding of hot ascending waters in deep borings is to be expected only in or near the Payette formation where it contains volcanic vents, or near hot springs. The Boise hot artesian belt extends along the base of the Payette Hills from the Hot Springs on the south to Cottonwood Creek on the north, a distance of 4 miles, and along this line hot water may reasonably be expected to be found in many wells. The clayey tuffs found at a depth of a few hundred feet evidently prevent the hot water from reaching the surface, and confine it within a certain horizon. Wells above an elevation of 2850 feet will probably not yield flowing water. The quantity is probably limited, so that after a certain number of wells have been bored the aggregate flow will decrease. Hot water may not unreasonably be expected if wells are bored in the lower Squaw Valley, where hot springs now issue, and it may possibly be obtained in Marsh and Horseshoe Bend valleys; but over the larger areas of the Neocene and Pleistocene formations it is very improbable that such water will be found, even in very deep wells.

Extent of the hot artesian belt.

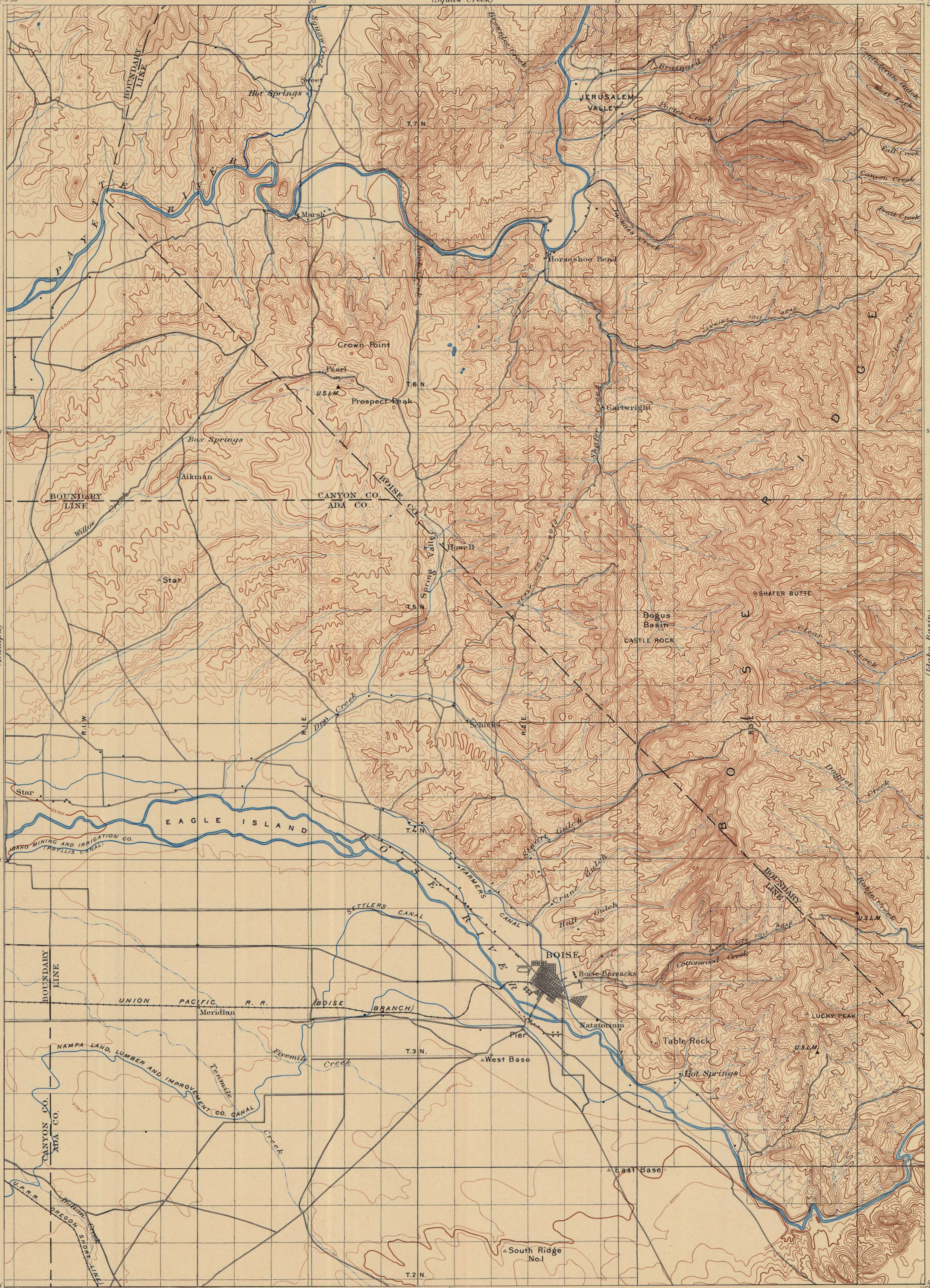
WALDEMAR LINDGREN,
Geologist.

June, 1897.

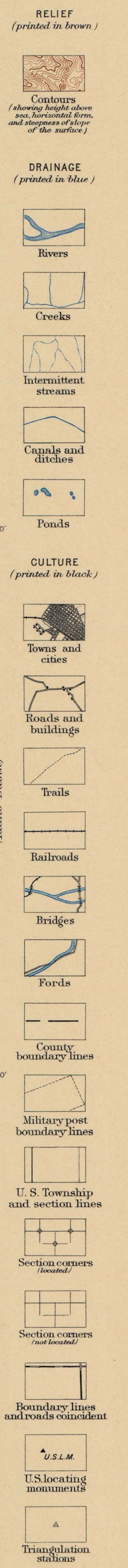
U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

TOPOGRAPHIC SHEET

IDAHO
BOISE QUADRANGLE



LEGEND



Names of adjoining published sheets are printed on the margin.

A.H. Thompson, Geographer.
W.T. Griswold, Topographer in charge.
Triangulation by F.M. Smith.
Topography by W.T. Griswold, E.T. Perkins Jr., Wm. P. Trowbridge Jr.
Surveyed in 1890.

Perkins / Griswold / Trowbridge

Scale $\frac{1}{125000}$

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour Interval 100 feet.
Datum is mean Sea level.
Edition of May 1897.

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HISTORICAL GEOLOGY SHEET

IDAHO
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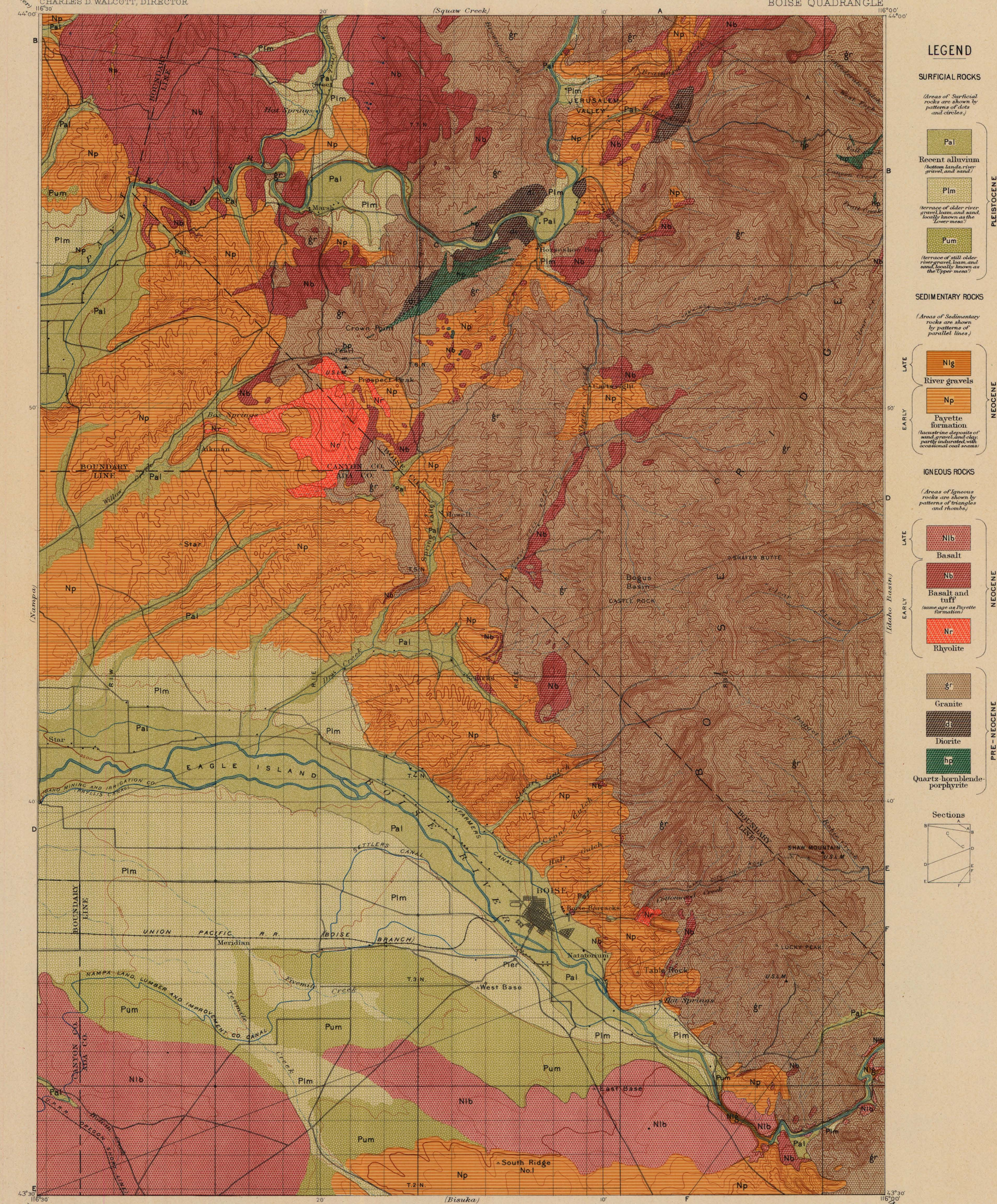

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Edition of April 1898

Geology by W. Lindgren.
Assisted by E.C.E. Lord.
Surveyed in 1896.

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ECONOMIC GEOLOGY SHEET

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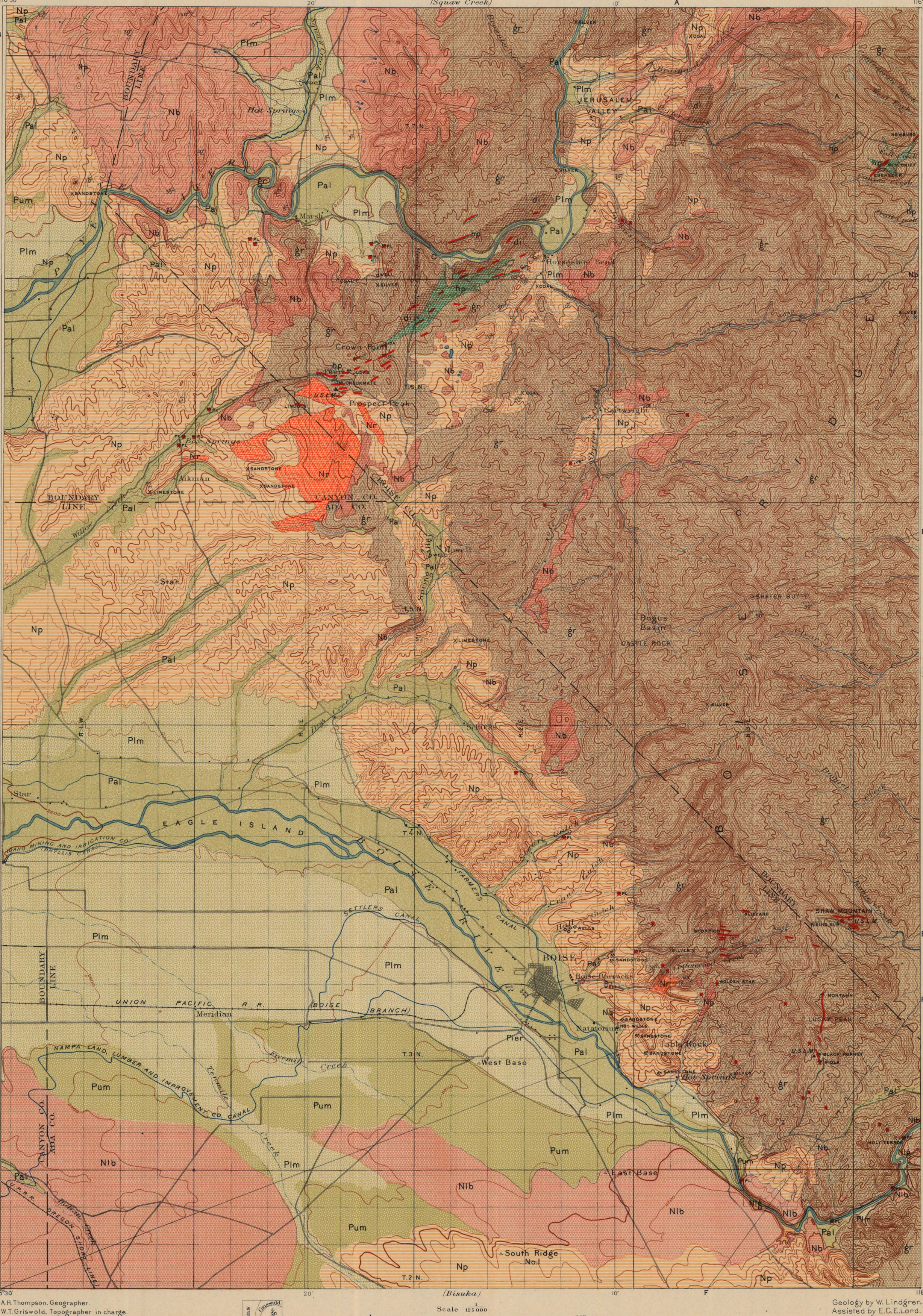


LEGEND

SURFICIAL ROCKS

(Areas of Surficial rocks are shown by patterns of dots and circles.)

PLEISTOCENE

- Pal — Recent alluvium *(bottom lands, river gravel, and sand)*
- Plm — *(terrace of older river gravel, loam, and sand, locally known as the "Lower mesa")*
- Pum — *(terrace of still older river gravel, loam, and sand, locally known as the "Upper mesa")*

SEDIMENTARY ROCKS

(Areas of Sedimentary rocks are shown by patterns of parallel lines.)

NEOCENE

- LATE: Nlg — River gravels
- EARLY: Np — Payette formation *(lacustrine deposits of sand, gravel, and clay, partly indurated, with occasional coal seams)*

IGNEOUS ROCKS

(Areas of Igneous rocks are shown by patterns of triangles and rhombs.)

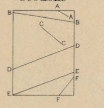
NEOCENE

- LATE: Nlb — Basalt
- EARLY: Nb — Basalt and tuff *(same age as Payette formation)*
- EARLY: Nr — Rhyolite

PRE-NEOCENE

- gr — Granite
- di — Diorite
- hp — Quartz-hornblende-porphyrite

Sections



- 20° *Dip and strike of stratified rocks and volcanic flows*
- 70° *Dip and strike of joint structure*
- 50° *Dip and strike of gold bearing veins, generally prospected*
- *Gold quartz mines*
- PL *Gold placer mines*
- *Quarries*
- *Prospects on gold deposits, dip and strike undetermined*
- X *Other prospects*
- O *Artesian wells*

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STRUCTURE-SECTION SHEET

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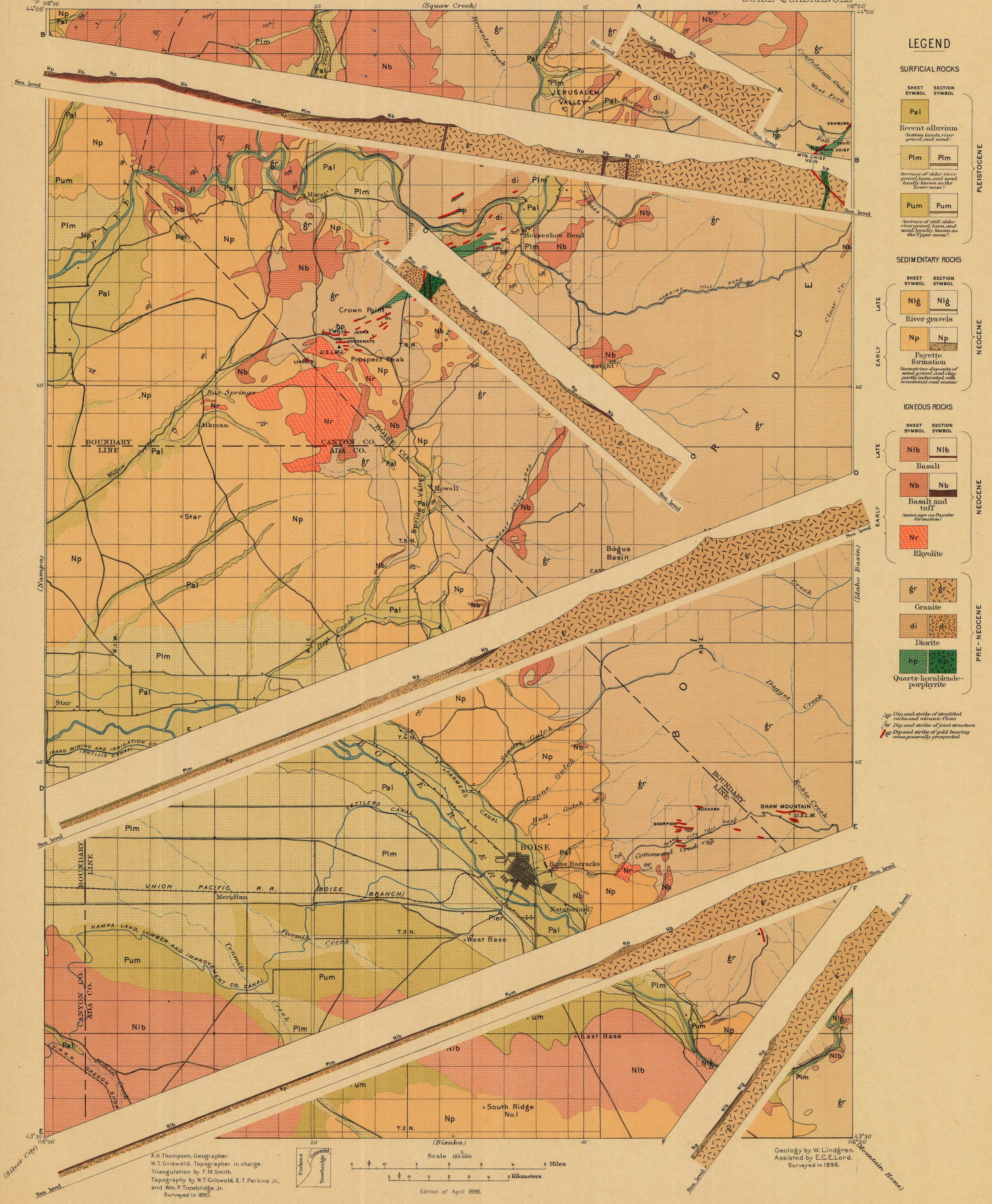
BOISE QUADRANGLE



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