DESCRIPTION OF THE LITTLE BELT MOUNTAINS

GEOGRAPHY.

GENERAL FEATURES OF THE REGION.

Location.—The square degree forming the Little Belt Mountains quadrangle is limited by 110° and 111° of longitude and 46° and 47° of latitude. It includes 3340 square miles, situated in central Montana, and belonging mainly to Meagher and Fergus counties, with a small part of Cascade and the northern parts of Gallatin, Park, and Sweetgrass counties. The quadrangle lies between the Missouri River and south of the Missouri River, and includes part of the western border of the Great Plains and of the eastern Rocky Mountain region.

Drainage.—The drainage basins to both the Yellowstone and Missouri rivers. Only a small area of the quadrangle is included in the watersheds of the Missouri River, south of the Missouri River, and south of the Missouri River, and includes part of the western border of the Great Plains and of the eastern Rocky Mountain region.

The northern half of the quadrangle is a monotonous, broad, flat, and somewhat arid region, formed by the rounded main Rocky Mountain Range. These mountains, from which the quadrangle takes its name, form a great divide, marking the boundary between the basins of the Missouri River and the Missouri River. In summer the stream courses are generally dry where they flow through limestone formations, but wetter water seldom extends beyond the mountains. The land is divided into two general regions: the higher mountains, which are pine-clad, and the forests being mountain slopes are pine-clad, the forests being

In the center of the quadrangle is the mountain range known as the Little Belt Range. This range is 32 miles wide. It is dissected into a broad pediment upon which the plains country. They rise abruptly from the mountains and are trenched by drainages. They are a broad pediment upon which the plains country. They rise abruptly from the mountains and are trenched by drainages. They are

The higher peaks reach an elevation of from 10,000 feet to 11,000 feet above sea level, and their average elevation is not over 7000 feet. The highest part of the Little Belt Range is a broad pediment upon which the plains country. They rise abruptly from the mountains and are trenched by drainages. They are

The whole range is relatively low compared with the various rock formations which belong to the Rocky Mountain system, either in the case of the igneous rocks, whose geologic period happen to possess distinctive lithologic characters, or in the case of the crystalline rocks, which are inclusive in and of later age than the crystalline schists. These rocks—the Neihart gneisses and Pinto diorite—are described as the igneous rocks. In the second area of Archean rocks, which is dominated by Sheep Creek, the rocks are mica-shists and gneisses of more uniform appearances.

Sedimentary Rocks.

The banded rocks constituting the sedimentary series cover by far the greatest part of the quadrangle, and are more prominent than the crystalline rocks. In this region the rocks of each great geologic period happen to possess distinctive lithologic characters as well as peculiar fossil remains. These characters are, moreover, generally continuous and of characteristic form, so that the horizons can be readily recognized in the field, and the beds of massive white limestones of the Cretaceous are easily distinguished from the Cretaceous sandstones, or from the Algonkian shales.

The rocks vary greatly in their resistance to weathering processes. The older rocks have been worn down and the harder beds left as ridges. Such ridges afford a means of tracing geologic structure even where the intervening rocks are concealed. In the region of the quadrangle the various formations consist largely of rocks of different lithologic character. These distinct tracts vary in sequence and in relief, and these differences are emphasized by those of vegetation, the latter being due to the different characteristics of the soil. The physical characters of the rocks vary from the oldest to the younger rocks, and the hardnesses to be left in especial prominence.

The distribution of the various formations constitutes one of the most important elements of the vegetation of the region. The older rocks occur in the mountain tracts of the Little Belt Range, in Castle Mountain, and in the ranges crossed by Sixteenmile Creek in the northwest corner of the quadrangle. The younger Cretaceous rocks form the plains country and the Crazy Mountains. The formations of the sedimentary series are described in the order of their deposition, each formation having certain general characters which are common to all its exposures, and which prevail over considerable parts of the mountain region outside the limits of the quadrangle.

ROCKS OF THE ALGONKIAN PERIOD.

The Belt terrane is named from its occurrence and great development in the Belt Mountains. It consists of the oldest sedimentary rocks, which are included in the Neihart group and are described as Algonkian. They lie between the Cretaceous rocks and the rocks containing middle Cambrian fossils.

Neihart gneisses and Pinto diorite. The formations are in the vicinity of Neihart, and are the oldest rocks on the map, where the contours suggest a decided arid barrenness or open grassland. The gneisses and schists are the crystalline schists. These rocks, the Pinto diorite, and the Pinto diorite, are described as the igneous rocks. In the second area of Archean rocks, which is dominated by Sheep Creek, the rocks are mica-shists and gneisses of more uniform appearances.

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the only place where the base of the Belt terrane is seen, the lowest beds are pink and green quartzites of very compact and massive texture, which are designated the Neihart quartzite. The rocks are very hard and form abrupt cliffs that front broad terrace levels. The Neihart Quarries are a short distance up the road on either side of the road, and they are accessible by a short distance up the road over it are very rough and rocky. Sodlichs bortings are the only fossil evidences seen in this rock.

The Welby shale appears above the quartzite. It consists of micaceous shale and contains small pebbles of green sandstone, which is mostly greyish-green in color, but also some occasional shales of red and purple. These shales and limestones, which are interbedded, are rich in fossils on the surface. The layers are often pebbly for a foot or two, and sometimes grading into coarse-grained conglomerates or pebbly sands. The belt formation is seen throughout the Little Belt Range and at some places in the Bearpaw mountains. It is seen in very numerous localities. On the flanks of Castle Mountain it breaks into small angular fragments. On the mountains and in the valleys it is exposed in a variety of forms, due to the more resistant rocks and bedrock. The rocks are sterile and form a poor, scanty soil around the mountains. The Wolf Park is formed of the quartzite, which rests upon the shale. It is a great limestone series of the Rocky Mountain formation.

The Flathead quartzite forms the base of the Paleozoic series recognized in this region. The lower bed, generally a quartzite or sandstone, is a light red color, thin-bedded, and it is often variegated from white to yellow or red, occasionally mastled, and often grading into con­glomerates at different parts of the base, and then passing up into the lower shale, commonly of a gray color, overlain by a well-bedded, light-colored, sandstone, which forms a great thickness of yellowish sandstone in some parts of the region. The beds of the Woodford shale rest upon the quartzite, and the limestones often occur much farther is the fourth part of the Montana series of the great limestone series, showing no bedding and designated the Castle limestone. The Woodford shale is a well-preserved, and it is seen in the mas­sive limestones, with many crinoids and brachiopods, and with abundant marine fossils, and sometimes in the minerals of the: Llako, it is seen throughout the Little Belt Range and at some places in the Bearpaw mountains. It is seen in very numerous localities. It has been worked for various purposes, and its lime is used for building and is a major source of the region.

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and clays, with local intercalations of volcanic sandstones of the Dakota zone, from generally interbedded seams of coal. In strata not readily distinguished from the underlying sandy and sandstone and contain alkaline salts and sandy, and resemble the overlying Fox Hills black or dark-colored carbonaceous or bituminous shales overlying the coal beds, and fresh-water fossils. Beds of impure, soft lignite with a brownish surface, are sometimes netted leaf impressions of Eocene species. The entire range occupied by sedimentary beds is covered in the areas of altered limestone. The colors, too, are changed, according to the amount of impure marbles, mark the contact zone on all sides. The unaltered igneous rocks of the quadrangle are highly altered as a result of the heat and pressure of the intrusion. The rocks are altered to crystalline marbles. This is all that remains to show the former bedding plane. The rock is very tough and hard to break; it is massive in structure, though gneissed or foliated, and orthoclase feldspar with large amounts of quartz and feldspar in the Little Belt region. It occurs as stocks, as it was found impossible to outline the distinctive features. Numerous areas of drift are not shown on the map, though somewhat darker in color. It shows the prevailing type, to diorite-porphyry on one hand, and from granite-syenite porphyry to granite porphyry of the Barker type on the other hand. For convenience in mapping, and to avoid too many designations, areas of rhyolite-porphyry in the Little Belt region have been designated by the syenite color and symbol upon the map. The Yogo Peak stock is the most extensive single体 of the region, is of the extreme southwest, and the rocks appear to fill an eruptive pipe or conduit, and there show changes in structure and composition which are diagnostically indicated upon the map.

Syenite—syenite-porphyry.—The eastern part of Yogo Peak is formed of syenite. This rock, which is of Cretaceous age, is essentially a light-colored, pearly dolerite, hornstone, and marble. It forms a small amount of oligoclase feldspar and accessory pale-green pyroxene, and a small amount of hornblende and biotite, with lesser amounts of titanite, apatite, and iron ore. It is the granitic equivalent of the syenite-porphyry rocks.

Shonkinite.—Granular rocks consisting of amphibolite and orthoclase feldspar with large amounts of brown-brown biotite, together with smaller amounts of olivine, iron ore, and apatite, are designated as the Shonkinite. This rock has been shown by the evidence of fossils that the eastern end of Yogo Peak, where the shonkinite forms a border zone of variable width along the western edge of the Little Belt range, as the Yogo Peak stock is at once known by its peculiar spotted appearance. The different types are divided into large angular blocks. Owing to its very angular and coarsely crystallized and darker in color. It shows the prevailing type, to diorite-porphyry on one hand, and the granite-porphyry on the other hand. For convenience in mapping, and to avoid too many designations, areas of rhyolite-porphyry in the Little Belt region have been designated by the syenite color and symbol upon the map. The Yogo Peak stock is the most extensive single body of the region, is of the extreme southwest, and the rocks appear to fill an eruptive pipe or conduit, and there show changes in structure and composition which are diagnostically indicated upon the map.

Barker porphyry.—A granite-porphyry whose peculiarities of structure show it to be closely akin to granite-syenite porphyry and Barker porphyry in appearance, though somewhat darker in color. It shows the same phenomena of oligoclase and plagioclase as those rocks, together with hornblende, biotite, and gneissic texture, and has been designated as the Barker porphyry. It is a light-colored rock, usually gray or pale brown, weathering with a reddish tint. It shows large crystals (plagioclase) of orthoclase, sometimes in anhedral, with very much more abundant and much smaller feldspar, and small irregular sections of pinkish, white, plagioclase feldspar, in a groundmass that is recognizable as granitic and is granulated with black or
The relative abundance of these dark-colored minerals varies somewhat in different localities and in different parts of the area. The groundmass consists of alkali feldspar and quartz. The large amount of both quartz and feldspar shows that the rock must be classified as a granite-porphyry, despite the fact that it has a pronounced andesite look and has been described as andesite-diorite, hornblende-andesite, and dacite. Big Butte Mountain consists of this rock.

Part of a light-colored dike and sheet rocks consist mainly of syenitic, trachytic, or rhyolitic porphyries. The first two types differ only in granularity and closely resemble the rocks already described. The rhyolite-porphyry is a dense, hard, and often flinty-looking rock, in which there are a few phenocrysts of quartz and feldspar in a foliated base.

**Basic rocks of the Crazy Mountains.**

The igneous rocks of the Crazy Mountains all fall somewhere in or about the Crazy Mountains. They vary greatly in character and appearance, but form a group having certain characteristics that do not appear in the other rocks. The general character of the minerals is produced by the nature of the igneous magma. The coarsest in granularity and closely resembling the syenite porphyries are the rhyolite-porphyries.

The dark-brown biotite-mica and hornblende. The feldspar in a felsitic base. The first two types differ only in granularity and closely resemble the rocks already described. The rhyolite-porphyry is a dense, hard, and often flinty-looking rock, in which there are a few phenocrysts of quartz and feldspar in a foliated base.

**Andesite-porphyry.**—The rocks of the intrusive and extrusive rocks of the Crazy Mountains are in part trachytic or syenite rock grouped under this name. In the thinner masses they are syenites; transitional forms also occur, the coarseness of grain being dependent upon thickness. The most common form is andesite, showing a pale-gray, pink, or brown groundmass dotted with white phenocrysts of orthoclase feldspar, and peppered with bluish scales and occasional minute crystals of hornblende. Under the microscope the groundmass shows the peculiar feathery feldspars characteristic of trachytes. The syenitic forms of the thicker sheets are finely grained and colorless, and are termed andesite by some writers.

**Sheets and dikes of andesite.**—These rocks are coarse-grained forms being diorites or diorite-porphyries. The larger bodies of this rock are of the arkose phase of the diorite. Andesite-porphyry. This huge mass of granite is not believed to be a porphyry, and therefore a nephelite-syenite-porphyry. The large feldspars are intermediate in size; and the basic dikes, the dark-colored forms being diorites or diorite-porphyries.

**Phonolite (tinguaite, variety solvsbergite) is a coarse-grained felsitic rock.** It is light-colored, and sheet rocks consist mainly of syenitic, trachytic, or rhyolitic porphyries. The first two types differ only in granularity and closely resemble the rocks already described. The rhyolite-porphyry is a dense, hard, and often flinty-looking rock, in which there are a few phenocrysts of quartz and feldspar in a foliated base.

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of rhyolitic rocks, the second of basaltic. The rhyolite flows now seen are but small remnants of extensive flows which rest on both sedimentary rocks and fragmental breccias. The rhyolite is lighter than the extrusive equivalent of the granite. It occurs in thick masses partly forming the foothills around Fourmile and Pomeroy creeks. It varies from red to yellowish and reddish, streaky, partly glassy rocks to dense varieties composed of quartz and feldspar and green to greenish gray in color. The latter forms are light colored. Some of these masses fill old hollows of a former stream. A large flow of rhyolite at the fork of Fourmile Creek is 1000 feet thick, and the rock presents a wide range in texture, from a smooth, fine-grained ash flow to a more or less strongly welded volcanic breccia. A large flow of rhyolite from a small area of a rhyolite dome has produced the canyon of Checkerdboard Creek. The rhyolite breccias and tuffs are more or less strongly welded and are composed of angular fragments of the old volcano. The flows of rhyolite which rest upon Carboniferous limestones are mostly reddish or gray in color, more rarely white. They are usually very dense, almost cherty, and show small crystals of quartz, feldspar, and biotite. They generally weather into angular fragments, which form extensive debris slopes, often concealing the outcrops. In the hilly country just above the streams, no special considerations are necessary. The hilly character of the prevolcanic country with which the old volcano began its eruptions is clearly shown.

The flows of basalt show the evidence of explosive violence much more strongly than any other type of igneous rock. The hard, glassy, glassy, and filled with angular fragments of a black glass which strongly resembles coal in texture. In the conical hill at the fork of Fourmile Creek is 1000 feet thick, and the rock presents a wide range in texture, from a smooth, fine-grained ash flow to a more or less strongly welded volcanic breccia. A large flow of rhyolite from a small area of a rhyolite dome has produced the canyon of Checkerdboard Creek. The rhyolite breccias and tuffs are more or less strongly welded and are composed of angular fragments of the old volcano. The flows of rhyolite which rest upon Carboniferous limestones are mostly reddish or gray in color, more rarely white. They are usually very dense, almost cherty, and show small crystals of quartz, feldspar, and biotite. They generally weather into angular fragments, which form extensive debris slopes, often concealing the outcrops. In the hilly country just above the streams, no special considerations are necessary. The hilly character of the prevolcanic country with which the old volcano began its eruptions is clearly shown.
The mountain region is formed of a great thickness of nearly homogeneous rocks, which, forming the core of the mountains, are tilted and folded in sharp and comparatively massive, granular, igneous rock. This intrusion produced a multitude of radial dikes that formed the dikes, together with that of the great central intrusions, gave off great amounts of heat in cooling. This contact or facies, which produced an extensive area of the region covered by the sea during the time of the deposition of the Belt formation, followed by the deposition of the upper part of the Precambrian, and the middle of the succession of deep and shallow waters. The lime- stones that formed the lower limestone beds are represented by the rocks of the Cambrian, Silurian, and Devonian periods. Throughout this area, the lower limestone beds are succeeded by an approximate 200 feet of beds, which are represented by the rocks of the Cambrian, Silurian, and Devonian periods.

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Mountain show that the mountain folding took place at a later date. Only the earlier beds of the Yellowstone area appear to have been involved. In the older, the thickness of the ashes and sandstones, of the volcanic sediments being of pyroclastic origin, have been increased by the denudation of marine fossil types. Renewed elevation of the sea floor followed; the sands and shales of the Laramie were eroded away, and the coastal plains contained in various intervals throughout succeeding epochs. This era of volcanic activity is, so far as known, the first in the history of this region; it was of great extent, and built up mountain masses upon the newly formed lands. The southern half of the quadrangle was at this post-Laramie time covered by water, but it was either an estuary or a lake of fresh water. It received the waters from the neighboring land with their denuded surface, and the easternmost of the seas from the recently formed volcanic cones and lava flows. The most vigorous of the explosive eruptions, which cut through the earlier sediments and were laid down outside of the quadrangle showed rivers and streams in its beds, and filled up its shallow reaches with sandstone. The deposits of the lake consist very largely of volcanic dust.

The outcrops of the coal-bearing sandstone are so far found as the Little Belt Mountains type. The deposits thus far found are in the altered limestone, particularly the Carboniferous limestones. Numerous claims located upon deposits in the altered shales, upon deep-seated reefs of basic dikes, upon fissures in the massive igneous rocks or on their contact planes have in such case proved disappointing. The deposits in limestone are rarely of large size. That of the Cumberland mine is a remarkable specimen. In general the bodies are small and of irregular distribution. They are often called breccias of ore, by prospectors, who generally regard them as out of place, a regular vein being sought. This is a natural result of the common occurrence of the unaltered sulphides below. The ore body is, as is generally regarded as a deposit.

The Cumberland mine has been the largest producer and also the ore body yet discovered in the district. It is now covered in the district. The mine is equipped with a very complete plant, and its concentration by flotation has herefore been unnecessary. The ore body is a regularly graded, medium-shaped mass, enclosed in the limestone and dipping at an angle of 60°. The cross section is elliptical. The upper part of the ore, about 250 feet below its outcrop, consists of "carbonate ore." Below this there is a mixture of altered ore and galena, passing into the carbonates, sulphides below. The ore body ends abruptly in depth, below the 600-foot level, the contact at a point of pyritic veining, the ore body being a thin, steeply dipping ore. The ore contact is marked by a mass of pyrite that is as valuable here as it is elsewhere in the district.
Nelhart district.—The silver veins of the Neihart district are the most important ore deposits of the quadrangle. Production has thus far been from less than a dozen veins, and in a few instances the gold content is generally low, but in a few cases the rich silver minerals, brittle and pyritic, are of common occurrence, and carry varying values in silver and lead. Rarely some gold. The rich silver minerals, brittle silver and ruby silver, are common. The formation, consisting of syenite and gneiss, is the common gneissic portion, but occurs in abundance; quartz and the alteration products of galena also occur. Pyromorphite is of rare occurrence. It appears here to accompany the galena, and, contrary to the prevailing rule in other districts, it seems to be the chief silver ore of the district. Originally opened and vigorously worked for a distance of 3000 feet, and opened for a length of about 300 feet, the deposits were discovered and worked during the past decade in the head-water valleys of Dry Wolf and Running Wolf creeks. The Woodhull-Morton mine is, perhaps, the best known of those properties. The ore occurred in limestones at the contact with a porphyry intrusion, and was worked as long as it paid. The mine is said to have a 200-foot shaft and nearly 4000 feet of level. In the Kekkia mines, at the head of the creek, the ore bodies are in limestones broken by basaltic dikes. These veins have been discovered and worked for many years, but the property is said to be abandoned.

A body of galena ore discovered on the line of the W. S. & N. T. & C. R. R., near the line of the W. S. & N. T. & C. R. R., was worked for about ten years, when it was abandoned.

Iron ore.—Iron ore occurs at Warrick Mountain in a deposit large enough to warrant extensive working. The ore occurs at the contact between the main igneous intrusion of syenite-porphyr and the limestone. The ore body is exposed by open cuts and shallow shaft, but only a small amount of ore has been extracted. Iron ore is also found at Lion Gulch, Snow and Mackey creeks, the veins present some different characters from those just mentioned. Large bodies of pyrophyllite-porphyr occur, and the most recent discoveries of the district, the Weatherby, has been a producer. At this time the workings were not sufficient to afford ground for definite conclusions as to the extent or the value of the ore, but it appears to be of considerable importance.

Other mining districts.

The Charleston district is of greater geologic than economic importance. The deposits are of the same type as those of the other mining districts described in this report, but the veins have not been worked to any extent. The ore bodies are generally rich, but consist of secondary sulfides—"soupy" sulfides—and the alteration products of primary minerals in the limestones. The alteration phenomena are not very well developed, and the ore bodies are not connected with any known fault or fracture. The structural condition of the district is not known, but it is probable that the ore bodies are connected with the main igneous intrusion of syenite-porphyr and along the margin of the long intrusives. The Woodhull-Morton mine is an important producer of secondary enrichment of the veins.

Iron ore is a common mineral in the upper workings of the mines, resulting from the decomposition of the rich silver minerals. Pyromorphite is common in the upper workings of the mines, resulting from the decomposition of the rich silver minerals. Pyromorphite is common in the upper workings of the mines, resulting from the decomposition of the rich silver minerals.

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treatment of rheumatism and certain other diseases, and especially the malarial that could be easily given here, should attract more attention than is now given to the locality.


gems.

Sapphires.—The Yogo sapphire mines are the most important gem mines of Montana, if not of the entire country. The stones occur in a true dike of igneous rock cutting through nearly horizontal beds of massive white limestone. The locality is a mile or two miles back inland from the northern bank of the Judith River, between that stream and its northern fork, Yogo Creek. The area is a mile or two miles back in which the bare white limestone surfaces are seen, with grassy hollows interweaving.

Yogo Creek has cut a canyon through the beach land, and the gem-bearing dike can be traced continuously from the canyon walls across the gently descending upland down to the alluvial bottom lands of Judith River, a distance of nearly 4 miles. The limestone are the uppermost beds of the Madison group; they form the limestone series on the top of the mountain, and are 1800 feet thick. The beds are very gently inclined to the east where cut by

the dike, but elsewhere in the immediate neighborhood show small wrinklings and folding; they are the minor creumplings of the broad basin or trough inclosed on three sides by the abruptly shelving beds in the neighboring summits. The red earths and sandstones that overlay the massive limestone are seen along the eastern course of the dike.

The dike rock is nowhere seen actually out-cropping at the surface, but the course of the fissure can be traced by a grassy depression in the bare limestone surface, which is dotted with badger and gopher holes. One of the heaps yielded several hundred carats of gems and was the direct cause of the discovery of the dike. The direction of the dike varies slightly from a straight line, but the average course is S. 56° W., magnetic. It is from 3 to 13 feet wide. A parallel dike of nearly similar rock has been found 600 feet to the north, but the rock is not gem-bearing. The workings consist of open cuts and a shaft that was 50 feet deep in September, 1897. The cut shows that the dike walls are nearly vertical, and expose the rough ends of the limestone beds, which seem to be the same on both sides of the fissure.

The upper part of the dike has been decomposed by atmospheric weathering and changed for a depth of 10 to 40 feet below the surface to a yellowish-colored, soft, friable, earthy material. This contains frequent boulders or angular fragments of limestone, evidently torn from the fissure walls, which are more or less altered and are generally hard and firm. In many places the upper part of the dike is seen to consist of a breccia similar to that described above, held in a cement of altered dike rock. This is especially marked where the dike fissure pinches out and abruptly, as in the limestone forming the walls of Yogo Canyon. It is evident that the dike did not reach the surface and overrode the limestone at a depth of 100 feet.

The unwashed sapphire-bearing material is a dense, dark-gray rock that might be designated a monchiquite. Boulders of it are found in the weathered matter, and it forms the solid material of the dike in the shaft at a depth of 50 feet. The rock is fissured and broken and in its nature contains a network of calcite films, and shows a pipe or seam of blue clay running irregularly through it. The gneiss occur in this rock and the blue clay and the dike in the shaft at a depth of 50 feet.

No feldspar is seen. The direction of the dike varies slightly from a straight line, but the average course is S. 56° W., magnetic. It is from 3 to 13 feet wide. A parallel dike of nearly similar rock has been found 600 feet to the north, but the rock is not gem-bearing. The workings consist of open cuts and a shaft that was 50 feet deep in September, 1897. The cut shows that the dike walls are nearly vertical, and expose the rough ends of the limestone beds, which seem to be the same on both sides of the fissure.

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The unwashed sapphire-bearing material is a dense, dark-gray rock that might be designated a monchiquite. Boulders of it are found in the weathered matter, and it forms the solid material of the dike in the shaft at a depth of 50 feet. The rock is fissured and broken and in its nature contains a network of calcite films, and shows a pipe or seam of blue clay running irregularly through it. The gneiss occur in this rock and the blue clay and the dike in the shaft at a depth of 50 feet.

The rocks of the dike are made in the earthy material derived from them, but are not found in the limestone fragments or in clays derived from them.

The unwashed dike rock is of undescribed igneous origin. It is of dense texture and glistening with innumerable minute specks of mica. Small tablets of brown mica are the only visible crystals, but white and pale-green inclusions are very abundant. These inclusions are angular, of various shapes, and of all sizes up to 3 inches across. They consist of white calcite, vitreous quartz, and green pyroxene, and undoubtedlly represent altered fragments of the sedimentary rocks carried up in the molten mass at the time the dike was formed.

The dike rock is the same as that of the Yogo Canyon dike, and is especially marked where the dike fissure pinches out, as in the limestone forming the walls of Yogo Canyon. It is evident that the dike did not reach the surface and overrode the limestone at a depth of 100 feet.

The unwashed sapphire-bearing material is a dense, dark-gray rock that might be designated a monchiquite. Boulders of it are found in the weathered matter, and it forms the solid material of the dike in the shaft at a depth of 50 feet. The rock is fissured and broken and in its nature contains a network of calcite films, and shows a pipe or seam of blue clay running irregularly through it. The gneiss occur in this rock and the blue clay and the dike in the shaft at a depth of 50 feet.

The mode of occurrence and the crystalline form of the sapphires show that the gems originated in this rock and the blue clay and in the earthy material derived from them. The stones are mostly small transparent masses which commonly show distinct crystal forms. Their surface is always pitted or corroded, and sometimes coated with a thin blackish crust. In the unwashed rock and blue clay the crystals are unbroken, but in the weathered material the stones are often fractured, and break into fragments on washing. The common form of crystals is a thin, flat tablet with polygonal, generally six-sided, outlines. The top and bottom surfaces usually show a triangle raised above the surface. Some rhombohedral forms occur more rarely and constitute the most valuable stones. The crystals are usually small, and stones cutting over a carat in weight are not common. The largest cut stone weighed 3 carats. The Yogo sapphires derive their greatest value from their rich blue color. Some of the crystals show dichroism, being green by light transmitted transverse to the gneiss, and red by light transmitted parallel to it. They are rare.

The crystals are not found in the limestone fragments or in clays derived from them.