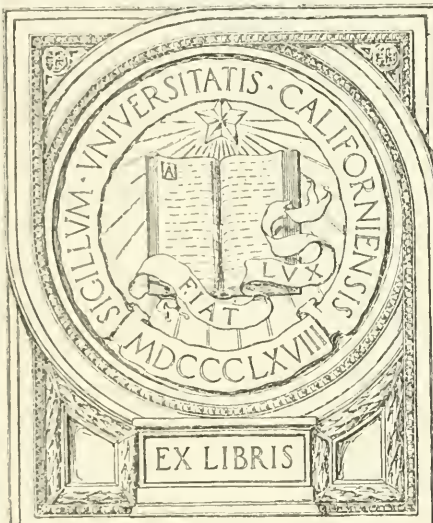
Geography and geology of
Fergus county.

by
Otis Willard Freeman



FERGUS COUNTY HIGH SCHOOL

BULLETIN 2

GEOGRAPHY AND GEOLOGY OF FERGUS COUNTY

BY O. W. FREEMAN

LEWISTOWN, MONTANA
1919

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ARGUS JOB ROOMS, LEWISTOWN, MONT.

PREFACE

This Geography and Economic Geology of Fergus County is intended to furnish information upon a variety of subjects. It is hoped that it will be of use in the public schools to the casual reader, and to the student. A large amount of research was devoted to securing the historical data and correct origin of geographic names, and the author expresses his sincere thanks for assistance rendered him by many citizens of Fergus County in securing this information, especially to R. von Tobel and W. A. Hedges. Thanks are also due the Bureau of Agriculture and Publicity at Helena for the plate used in printing the map of Fergus County and to the Cook-Reynolds Co. for permission to use several half tones. Superintendent P. V. Cardon of the Moccasin Experiment Station gave some excellent suggestions for the chapter on soils and their effect on agriculture.

There has been a constant demand for general information regarding the geology and mineral resources of the county, and practically every mine, prospect and corner of the county has been visited in the preparation of this report. Lack of space forbade a more detailed report, and those in search of detailed information are referred to the special reports listed in the bibliography that contains the more useful of the publications on the county. Publications of U. S. Geological Survey were of much value in the preparation of the chapter on Geology. The author is willing at all times to furnish any further information that may be in his possession and to co-operate with anyone interested in the lines covered by the report. Those wishing a copy of this report can obtain it gratis by addressing the Board of Trustees of the Fergus County High School at Lewistown, or the principal of the institution. The author requests the forbearance of the reader of this bulletin, as it was prepared under the stress of many other duties, and was seriously hampered by the incendiary fire that destroyed photographs, halftone engravings and much data that had been gathered for use in the bulletin. If any reader can furnish further information about the early history, geography and mineral resources of the county, they are urged to communicate such information to the author or other instructors connected with the High School, as it is hoped to make the institution a clearing house of accurate information about the county.

This is the second bulletin to be issued by the Board of Trustees of the Fergus County High School. Bulletin No. 1 was published over a decade ago on the "Bird of Fergus County" and the author was Mr. P. M. Silloway, a former principal of the High School.

The fire that destroyed the school bulding last year unfortunately also destroyed almost all of the copies of this bulletin. Other bulletins are planned for the future on the "History and Civics of Fergus County," etc. The writer wishes to commend the long-sighted wisdom and broad mindedness of the Board of Trustees shown by their efforts to disseminate local information by means of these bulletins.

LIST OF CHAPTERS

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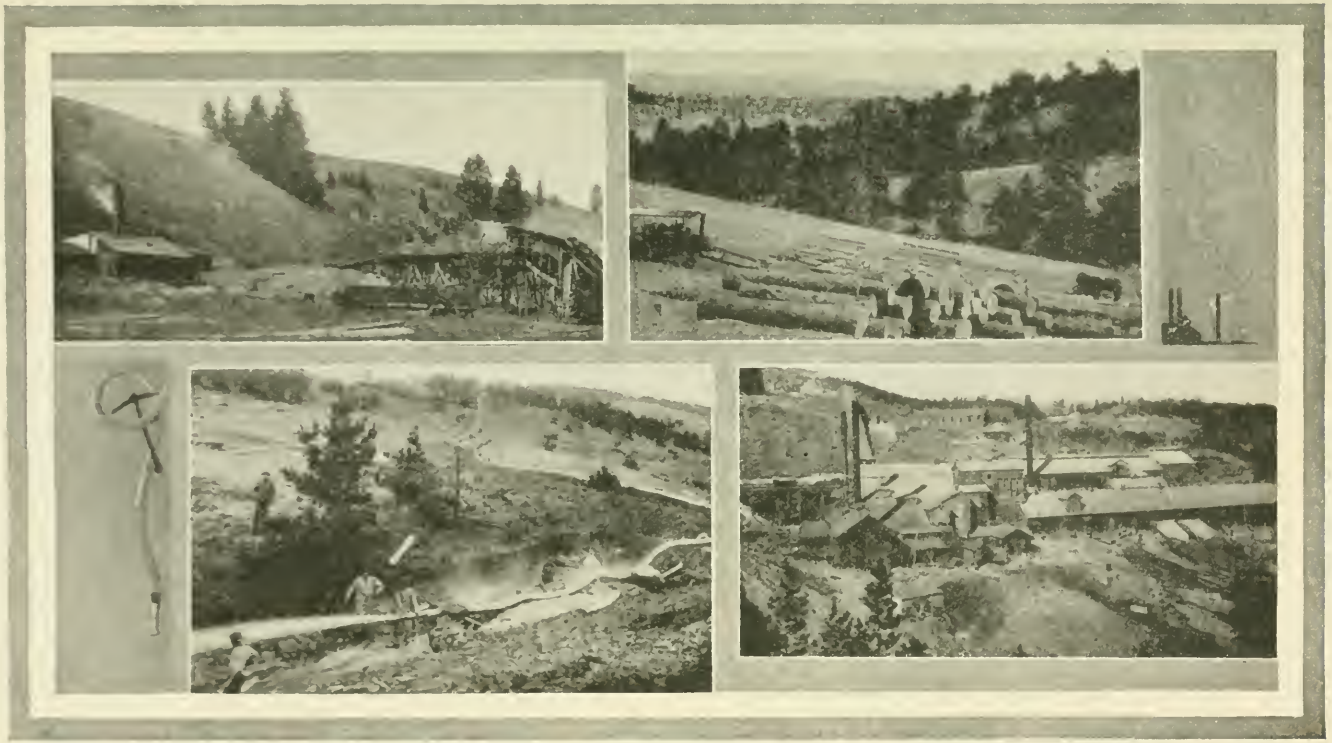
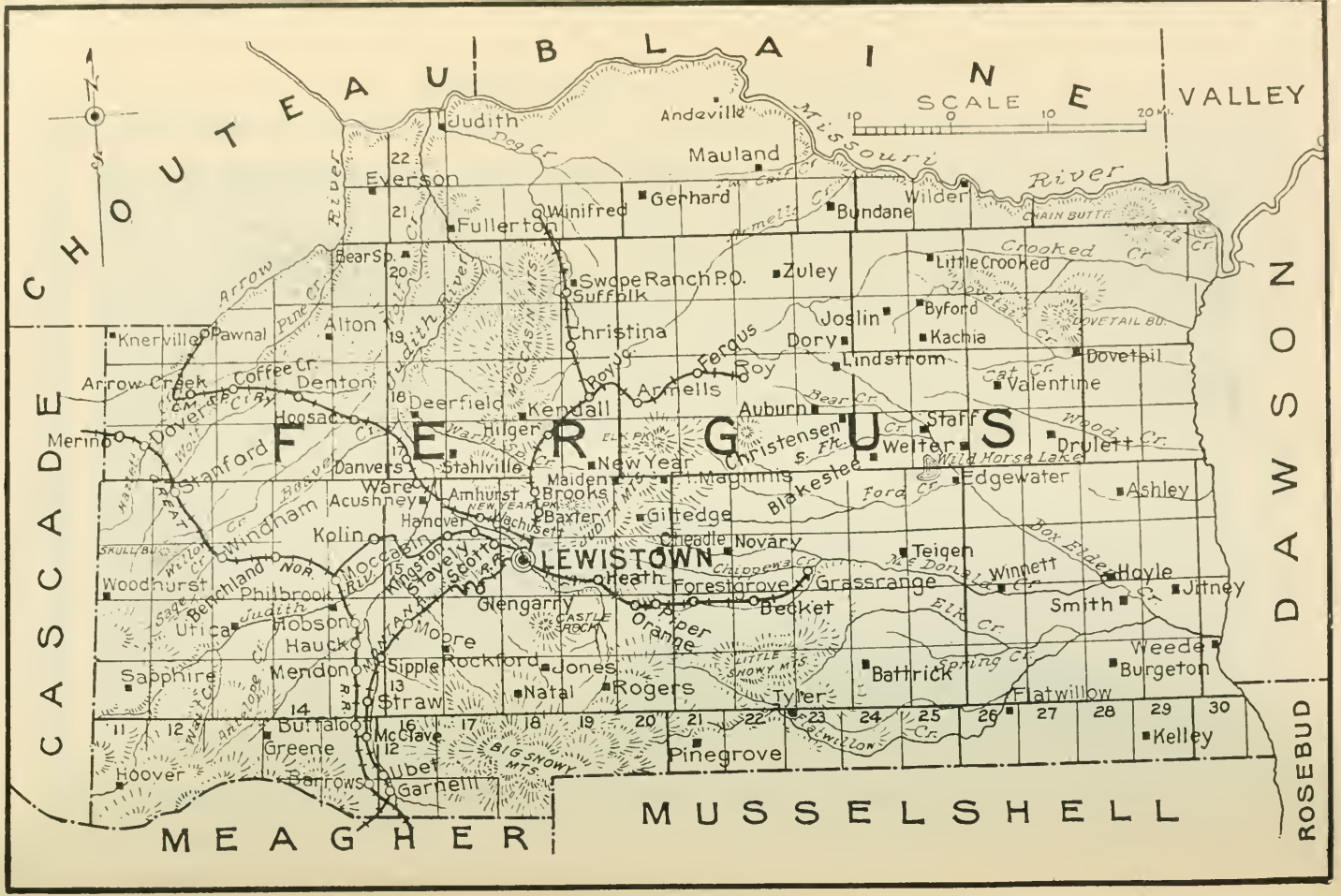


VARIOUS INDUSTRIES OF FERGUS COUNTY.



MAP OF FERGUS COUNTY.

GEOGRAPHY AND ECONOMIC GEOLOGY OF FERGUS COUNTY

CHAPTER I.

Area, Location, Physical Features and Development of Fergus County.

Fergus County is in the center of the State of Montana. It has an area of about 7,300 square miles and is the largest county in the state. It is almost as large as the State of Massachusetts. Its greatest length is about 122 miles, or nearly as far as from New York to Albany, and its greatest width is about 78 miles.

The center of Fergus County is about 109 west longitude and 47 north latitude. The Missouri River forms the northern boundary of Fergus County and the Musselshell River forms the eastern boundary; Arrow Creek forms part of the northwestern boundary; Chouteau, Blaine and Phillips Counties lie to the north; Garfield County, and a few miles of Rosebud County to the east of Fergus. Musselshell, Wheatland and a corner of Meagher Counties bound Fergus on the south, and Cascade on the west. More counties touch Fergus than any other in the state.

The county forms a part of the Great Plains Province, in which is included the eastern two-thirds of Montana. The lowest altitude is at the mouth of the Musselshell River, about 2,300 feet, and the highest, on the summit of the Snowy Mountains, over 8,600 feet. Lewistown has an altitude of abut 3,900 feet, which is a little over the average for the county. The Big Snowy Mountains extend about 25 miles on the southern boundary of the county. The Judith Mountains are in about the middle of the county and reach an elevation of over 6,000 feet, nearly half a mile above the plains about their base. West of the Judiths a few miles are two small isolated mountain groups, the North Moccasins and the South Moccasins. A connected series of high hills extend south from the Judiths to Alaska Bench east of the Big Snowy Mountains and are known collectively as the McDonald Creek Divide. A very wooded country is found east and northeast of the Big Snowy Mountains, which has been rather inaptly named the Little Snowies. Black Butte, nearly 6,000 feet high, east of the Judiths, forms a prominent landmark for Eastern and Northern Fergus County. The Little Belt Mountains are found in Southwestern Fergus and their main eastward extending ridge forms part of the boundary of Fergus County. Over the line in Chouteau County are the sharp peaked Highwood Mountains with flat-topped Square Butte east of them, which forms the most famous landmark of Central Montana. Across the Missouri, the Bearpaw and Little Rocky Mountains are visible from half of Fergus County. Western Fergus County is almost surrounded by mountains and form the widely known Judith Basin. Between the Little Belt and Big Snowy Mountains is Judith Gap, which is the most practicable route north and south for automobiles or railroads between Tyler and Neihart, a distance of about 90 miles. An auto road could be built in the valley between Alaska Bench and the Big Snowies without much trouble that would

make a good outlet for the north side of Musselshell County for trade and communication with Lewistown.

Outside the mountains the usual surface of the county is composed of extensive benches, slightly sloping for miles from the mountains towards the main drainage lines, or especially in Eastern and Northern Fergus, of a gently rolling country, with broad valleys. The Missouri and Musselshell Rivers have entrenched themselves several hundred feet below the level of the Great Plains, and steep breaks or badlands have thus developed between the benches and the valley flats or broad plains commencing to be formed along the rivers. The tributaries to the large rivers have often cut back for many miles into the benches, eroding them into extensive badlands.

The Judith River is the chief stream that has its source in Fergus County. It rises in the Little Belts and flows across the Judith Basin into the Missouri. Its chief tributaries on the east are Big Spring, Ross Fork and Warm Spring Creek; Running Wolf and Sage Creeks are of the most importance on the west. Arrow Creek rises in the Highwoods, and Dog Creek has its source in the North Moccasin Mountains. Both empty into the Missouri a few miles from the mouth of the Judith, in Northwestern Fergus. The chief streams of Eastern Fergus are Flatwillow, McDonald and Box Elder Creeks, which rise mainly in the Snowy and Judith Mountains and unite a few miles above where Flatwillow empties into the Musselshell in Southeastern Fergus. Armells Creek flows from the Judiths northeast to the Missouri. Crooked Creek drains Northeastern Fergus and flows into the Musselshell about two miles from where it empties into the Missouri.

The rich well grassed valley of the Judith River furnished an ideal range for the buffalo. It was sheltered from the blizzards of the plains by the surrounding mountains, and was a favorite resort of the Indians. French Canadian fur traders were probably the first representatives of the white race to visit Montana, and a few of them, led by De la Verendye, explored Central Montana in 1743. Lewis and Clark's expedition ascended the Missouri River in 1805 and discovered and named the Musselshell and Judith Rivers in May of that year. Many trappers and traders followed this expedition and trapped and hunted beaver, wolves and buffalo for many years. Small forts were established near the mouth of the Judith River in 1832 and 1842, but were abandoned after a few months. After the discovery of gold at Virginia City and Helena, steamboat traffic greatly increased on the Missouri River. During periods of low water the boats were unable to ascend the river to Fort Benton and their cargoes were landed at Cow Island and Fort Musselshell, and hauled by bull teams across the Judith Basin through Judith Gap to White Sulphur Springs, and thence over the Belt Mountains by way of Diamond City and Canyon Ferry to Helena. As a result of trouble with the Sioux Indians, Fort Musselshell, which had been founded in 1866, was abandoned in 1874 as a trading post and steamboat landing in favor of Carroll, at the present site of Wilder.

Commencing in the sixties, freighters often wintered in the Basin, being attracted by the splendid growth of grass, and by the seventies there were several well recognized camping sites in the county, as at Camp Lewis, at the junction of Big Casino and Big Spring Creeks. Many stockmen and miners came into the county in the late seventies and

early eighties and several little settlements were started. Reed's Fort, on the site of Lewistown, was built in 1873 and a postoffice established in 1880. Soon after this the original townsite of Lewistown was platted from part of F. A. Janeaux's homestead, and since only a few people were expected to live there, a fence was takn as a starting point, with the result that the streets of Lewistown do not run with the compass. The discovery of gold at Yogo, in the Belt Mountains, led to a rush there in 1879, but the deposits proved disappointing and the town was soon practically abandoned. Maiden was founded in 1880 as a result of gold being discovered there. Fort Maginniss was built in 1880 and garrisoned with U. S. troops to protect the cattle and sheep men from the Indians. Old Cottonwood, Philbrook (four miles from the site of Hobson), old Stanford (about two miles from present site), Grass Range, old Geyser (just over the line in Cascade County), Oka, Ubet, Bercail (just south of Judith Gap), Utica, Maiden and Lewistown were the chief centers where the ranchers of the eighties could purchase supplies, and the cowboys and miners buy strong drink or satisfy their taste for gambling. Gilt Edge was started in 1893 when gold was discovered there.

Until the construction of the Montana Railroad (called the "Jawbone") to Lewistown in 1905, goods were freighted into the Judith Basin country from Fort Benton, Helena and Billings. From 1880 to 1905 mining and stock raising were the chief industries in Fergus County. Since then grain gowing has proved to be a very profitable enterprise, and thousands of homesteaders came into the county. In the last 15 years the greater part of Fergus County has been homesteaded and little excpt vry rough land remains open to entry. Several branch railroads have been built primarily to haul the grain to market and many cities and towns have been founded as supply centers and grain shipping points for the farmers.

Fergus County was organized in 1885 and included the territory between the Musselshell and Missouri Rivers. Musselshell County was formed in 1912 and included that part of Fergus County south of the Snowy Mountains. Our county was named after James Fergus, one of the pioneer stockmen, who settled at Armells n 1880.

TYPE OF MODERN RURAL SCHOOL.

CHAPTER II.

Cities and Towns of Fergus County.

The population of Fergus County in 1919 is over 40,000 compared with 17,385 in 1910, 6,937 in 1900 and 3,514 in 1890, when Fergus County included much of what is now Musselshell County.

The Great Northern Railway between Billings and Great Falls runs through Fergus County with a branch to Lewistown from Moccasin. This branch will soon be extended east from Lewistown 200 miles to connect with the Great Northern extension in Dawson County, which is completed to Richey. The Chicago, Milwaukee & St. Paul Railroad has a branch from Harlowton to Great Falls passing through the county. From Lewistown, branches of the Milwaukee extend east to Winnett and north to Hilger and Winifred, with another branch from Hilger to Roy.

Lewistown, the county seat of Fergus County, has a population of 8,000. It has paved streets, municipal water system, and remarkably fine office buildings, churches and public buildings for a city of its size. The county fair is held annually in Lewistown. There are four public schools and one county high school, three newspapers and a monthly magazine. Lewistown has four banks with combined resources of over $7,000,000. There are four wholesale houses, two creameries, a brick yard, concrete tile works, flour mill, railroad repair shop, planing mill, good hotels and many modern stores, garages, lumber yards, etc., that carry very complete stocks. South Lewistown is at the Milwaukee Railroad yards. Seven miles west of Lewistown at Hanover, is a large new portland cement plant and a gypsum wall plaster mill.

Moore has a population of about 700. It is on the Milwauke Railroad and is the trading center for a very rich farming district. It is a modern city with good schools and churches, newspaper, strong banks, large elevators and up-to-date stores. Glengary is a small grain shipping point between Lewistown and Moore.

Garneill and Straw are small towns on the Milwaukee Railroad, south of Moore, and are situated in rich farming districts.

Denton has a population of over 600 and is the largest city in Northwestern Fergus County. It has two newspapers, flour mill, four elevators, good schools, banks and store buildings and many modern residences. An immense amount of wheat is annually shipped from here.

Coffee Creek has a population of about 200. It has four elevators and is an important shipping point for wheat and trading center for the ranchers of the Arrow Creeek bench. Amherst, Ware, Danvers and Hoosac are railways stations and trading points of local importance betkeen Lewistown and Denton. Arrow Creek, beyond Denton, is also a shipping point for grain. Everson is a small trading point 28 miles north of Denton.

A number of good towns are found along the Great Northern through the Judith Basin. Buffalo is the center of an excellent farming district in the southern part.

Hobson is in the center of the Judith Basin and has a population of about 400. It has a flour mill, elevators, newspaper, good schools, banks and stores. Utica, 12 miles west of Hobson, is an old town, founded in the days of the cattlemen. A splendid farming country lies between Hobson and Utica.

Moccasin and Benchland are good small towns on the Great Northern

and are important grain shipping points. Moccasin has a population of about 250 and considerable business is done there. The Great Northern branch to Lewistown starts there. The largest town between Moccasin and Lewistown is Hanover, which has a population of about 350 and is a company town, built by the Three Forks Cement Company. The cement plant and gypsum mill provide employment for about 125 men. Kolin and Ross Fork are important grain shipping stations.

Windham is a town of about 300 and is in a good farming country. It has stores, newspaper, bank, elevators, etc. Lehigh is a coal mining town, five miles from Windham. It has a population of nearly 1,500, making it the second largest community in Fergus County. The Cottonwood Coal Company operates two mines there with an output of 1,000 tons daily, which is mostly used by the Great Northern Railway. Six hundred men are employed in the mines. Lehigh is a company town and the company retains ownership of the buildings. It has a bank, good stores, hospital, large coal washing plant, etc. A branch railroad connects it with Windham.

Stanford is an important city in Western Fergus County. It has a population of 500. Stanford has good stores, banks, newspaper, churches, city hall, elevators, etc. There is excellent farm land around it. Dover and Merino are stations on the Great Northern, west of Stanford.

North of Lewistown on the Milwaukee, Hilger, population 300, is an important trading and shipping center. It is the railway station for Kendall, (population 400), a good mining town, five miles west. Two mines at Kendall are operating and produce about half a million dollars of gold a year. The mines at Kendall have produced in all about $9,000,000 in gold. There is excellent farming and grazing contributary to Hilger, and to Brooks, which is 10 miles north of Lewistown.

Christina and Suffolk are small towns on the railroad between Hilger and Winifred, and Armells is between Hilger and Roy.

Winifred is a city of about 400 inhabitants and the terminus of the Dog Creek branch of the Milwaukee. An immense grain growing and stock raising territory is tributary to Winifred. The town was started in 1913 and now has banks, elevators, stores and substantial business blocks.

Roy has a population of about 350 and is the terminus of a branch of the Milwaukee from Hilger. A great area of grazing and agricultural land extends for miles around Roy. It is an important trading and shipping town and much business is done there. Valentino is 25 miles east of Roy and is a good small town, in the midst of many undeveloped resources. Lack of transportation holds back development. The country north of Roy and Valentine has been homesteaded very extensively in the past five years. Lindstrom is a postoffice between Roy and Valentine.

Malden, in the heart of the Judith Mountains, and Gilt Edge, 16 miles northeast of Lewistown, are old gold mining towns. While they show many evidences of decay of the mining industry yet mines and mills are still operated and a production of nearly a quarter of a million dollars in gold is reached annually. About $10,000,000 in gold has been produced from the gold mines in these towns.

There are two important cities east of Lewistown, on the Milwaukee Railroad, Grass Range and Winnett.

Grass Range (population 300), has banks, newspapers, elevators, hotels, creamery, flour mill and good stores. It is the trading point for a big farming and good stock country. Forest Grove is a small town on the railroad between Lewistown and Grass Range. Teigen is between Grass Range and Winnett. Cheadle and Novary are east of Lewistown, on the Great Northern extension.

Tyler is a small settlement about 15 miles south of Grass Range, in Southern Fergus County.

Winnett is a modern city of 450 inhabitants, and the present terminus of the Milwaukee railroad. Two large, private irrigation projects are in successful operation within a few miles of the city, and vast acreage, suitable for the growing of spring wheat and corn, is available for farming by dry land methods. Smith is a postoffice about 12 miles east of Winnett on the proposed extension of the Great Northern and the Milwaukee. Flatwillow is a postoffice about 15 miles south of Winnett.

N BAR RANCH.

CHAPTER III.

Rocks and Minerals of Fergus County.

The rocks of Fergus County include both igneous and sedimentary. The sedimentary rocks include both oceanic and terrestial sandstone, conglomerate and limestone, besides shale, coal, gypsum and volcanic ash. The igneous rocks include both extrusive and intusive types. The Highwoods consist chiefly of old volcanoes built of lava flows but are outside the boundary of Fergus County. The extrusive rocks in the county are volcanic deposits along Arrow Creek, near the Highwoods. Intrusive igneous rocks are of many types. Those of the Judiths are fully described by L. V. Pirsson in the Eighteenth Annual Report U. S. Geological Survey, pages 557-587; those of the Little Belts in the Twentieth Annual Report U. S. Geological Survey, pages 463-581, and those of the Highwoods in Bulletin 257. Those interested in a complete description of the rocks are referred to these reports. The chief igneous rocks will be described very briefly in this bulletin.

The igneous rocks intrduded sedimentary strata in the form of laccoliths, stocks, sills and dikes. The laccoliths chiefly intrude Cambrian and Mesozoic shales and cause an arching up of the overlying strata to form great domes. Laccolithic intrusions account for the Judith and Moccasin Mountains and for Square Butte, Cone Butte, Wolf Butte, Black Butte and for some peaks in the Little Belts. In stocks, the igneous rocks have broken across the sedimentary rocks more than uplifting them and the intrusions are larger. Big Baldy Mountain, Yogo Peak and Woodhurst Mountain, in the Little Belts, and Judith Peak, in the Judiths, result from stocks. Sills are igneous intrusions along bedding planes of sedimentary rock and are common in the Moccasins and Judiths. Dikes are rather vertical intrusions that fill cracks in the sedimentary or other igneous rocks. They occur in the Judiths and Little Belts and are very common around the Highwoods radiating out in all directions from the mountains. A few igneous dikes occur in Northern Fergus County, near the Missouri River.

Except for a few dark colored, basic dikes along the Missouri and the sapphire bearing dike at Yogo, the igneous rocks are of an acid character usually low in lime, iron and magnesia and are light colored in appearance. They are high in silica, often 75 per cent. Feldspar is a common mineral constituent and often orthoclase is found in very well developed large crystals, which results in the rock being classified as a porphyry. The igneous rocks include granite, rhyolite, syenite, diorite and phonolite porphyries in the Judths and granite, diorite and phonolite and rhyolite porphyries in the Moccasins. The rhyolite porphyry is often called "quartz porphyry" and is the most common rock of the mountains. Syenite, granite, diorite, monzonite and shonkinite porphyries are found in the intrusive bodies of the Little Belts. The rocks of Square Butte and of the phonolite dikes of the Judiths are high in potash and other alkalies. The most common igneous rocks in the mountains consist of quartz, orthoclase, feldspar and biotite mica and is rather easily decomposed and disintegrated by the weather, so that good exposures are few.

MINERALS.

Elements.

Few native elements have been found in Fergus County. Gold is by far the most important metal found. Usually the gold ores contain no visible gold, but rich pockets in the Spotted Horse and other mines at Maiden were filled with both free gold and tellurides of gold.

Some placers contained native gold in Alpine Gulch and on Armells Creek inthe Judiths, in the North Moccasins, and at Yogo, in the Little Belt Mountains. Gold is a soft metal and it is nearly 19 times as heavy as water. No crystals of gold have been found. Gold occurs in small veins in igneous rock and in replacement deposits along the contact of limestone and intrusive porphyry. No native silver has been found, but a small specimen of native copper was picked up as float in the North Moccasins. It was probably formed by reduction from the original sulphides.

Among non-metals, graphite and sulphur occur in the native state in Fergus County, but not in commercial deposits. Graphite is only about twice as heavy as water and is quite soft. It is black in color and has a black streak. It is found at Black Butte, where it was formed by Cretaceous coal being metamorphosed by being brought into contact with intrusive igneous rock. The graphite is compact but will not burn. Coal is very common in the Kootenai and Judith River formations and occurs in thin beds in other formations. Small amounts of native sulphur have been observed in moist black shale of the Ellis formation and Cretaceous shales where it probably results from the reduction of gypsum. It is whitish yellow in color, insoluble and light in weight. It burns with the characteristic odor of burning sulphur. The sulphur has been found near the head of McDonald Creek and small traces in the badlands.

Sulphides and Tellurides.

Argentite or silver glance. Silver sulphide crystallizes in cubes and octahedrons, but good crystals are seldom found in Fergus, although common at Neihart, in the Little Belts. It is blackish gray in color and streak and has a metallic luster. Argentine occurs with lead and zinc sulphides, and has been found near Gilt Edge, Maiden and Armells, in the Judiths; Wolf Creek, in the Little Belts, and in the Moccasins. The total production of silver in Fergus County is probably $30,000-$40,000.

Galena is the lead sulphide. This is the important ore of lead and usually contains silver and zinc in Fergus County and often a little copper. Crystallizes in cubes and octahedrons, but usually found in disseminated masses. Galena possesses perfect cubical cleavage, has a bright metallic luster and a lead gray color and streak. The mineral is easily scratched and is 7½ times as heavy as water. Galena has been found chiefly in pockets as a replacement of limestone near the contact with intrusive porphyry. Occurs at Cave mine, on Armells Creek; War Eagle, at Maiden; West Kendall, in the North Moccasins; Hardly Able, in the South Moccasins; near Gilt Edge, in Cone Butte district, and on Wolf Creek, in the Little Belts. Probably over $100,000 in lead has been produced from Fergus County mines, all of which were small.

Spalerite, zinc blend or black jack. Zinc sulphide crystallizes in cubes and tetrahedrons but crystals are very rare in Fergus County, where it

is usually found with massive galena. Harder and lighter in weight than galena. Usually has a metallic luster but it may be resinous. Color is brown or black and the streak is light yellowish. Spalerite often is found with galena in Fergus County as near Gilt Edge and on Wolf Creek, in the Belts, and on the Hardly Able and War Eagle properties. It is unwelcome to the miner as when present in considerable amounts it interferes with the smelting of the lead. Hence the smelters penalize such ores instead of paying for their zinc content. The result is that the mining of lead zinc ores has usually proved unprofitable in the county and the total production of zinc has been valued at only a few thousand dollars. A large output of zinc ore is now coming from the mines at Neihart, in Cascade County and is being used by the new wet process zinc refinery in Great Falls. Probably some of the zinc ores of Fergus County are suitable for use in this plant.

Chalcopyrite, copper iron sulphide. Medium hard mineral and over four times the weight of water. This mineral has a metallic luster and a brassy yellow color, often appears iridrescent. It has a tetragonal crystallization. It has been found on Armells Creek, in the Judith Mountains. The original copper deposits in Fergus County were probably sulphides, but they have been usually oxidized to silicates, oxides and carbonates, and are developed insufficiently to expose the sulphides that possibly underlie the weathered portion.

Pyrite, Fool's gold or iron pyrites, iron disulphide. Small pyritic veins in porphyry sometimes carry small amounts of gold which by weathering produce small placers as in Alpine Gulch and the south slopes of the North Moccasins. Hard as a steel knife. Sp. Gr. is about 5. Occurs in cubes whose faces are often striated and sometimes in octrahedrons and pyritohedrons. Often found in masses and as thin flakes in coal beds. The color is pale brass yellow with a metallic luster. Pyrite is harder than chalcopyrite and paler in color. It is brittle. It is easily altered to oxides of iron. Pyrite originally accompanied the gold deposits of the mountain groups, but in itself is of no economic importance here.

Sylvanite, the gold silver telluride, calaverite, the telluride of gold occur in the mines at Maiden associated with fluorite. The tellurides are soft, heavy, Sp. Gr. 8-9. They have a metallic luster and silver white color. The crystallization is monoclinic, but few distinct crystals have been found. The structure is bladed or granular. Gold tellurides probably also occur at Gilt Edge and Kendall, but not in crystallized forms. Most of the gold originally existed as tellurides but by the decomposition of the ores much of the gold was set free, although it can seldom be seen in the old. The total production of gold in Fergus County is over $18,000,000.

The compounds of silver, antimony, arsenic and sulphur occur at Neihart, in the Little Belts, but have not been identified from Fergus County ores.

A small amount of nickel has been reported from a copper prospect on Armells Creek in the Judiths. It is probably in the form of the sulphide, millerite.

Sulphates.

Small amounts of barium have been reported from rocks of Fergus County but crystals of barite have not been found.

Gypsum is the hydrated form of calcium sulphate. When calcined or heated most of its water of crystallization is driven off and it is changed

to plaster of paris. Gypsum is a soft mineral, usually whitish and it varies from transparent to opaque. It occurs in two ways. First in thick massive beds as at Hanover and Heath, and secondly, as disseminated crystals in the black Cretaceous shales of Northern and Eastern Fergus County. Gypsum crystals are usually flat and diamond shaped. The crystals have good cleavage planes and can be split into thin pieces which makes gypsum resemble mica. Gypsum, however, is brittle, while mica is elastic, so it is easy to distinguish between the two. Gypsum crystals are often striated by the solvent action of water. Gypsum dissolves rather freely in water and causes permanent hardness of water. Gypsum has little effect on plants and can sometimes be added to alkali soils with beneficial effect as it reacts with the alkali and forms harmless salts. Gypsum is mined at Hanover and used for making wall plaster. A small quantity is also used as a retarder in Portland cement. A new gypsum plant will soon be built at Heath.

Chlorides, Etc.

Halite, common salt, sodium chloride, occurs in much ground water in Fergus County and in alkaline ponds, and is the chief constituent of "white alkali" deposits where it is often accompanied by magnesium and potassium salts. Alkaline salts, near Square Butte, have assayed 28 per cent. potash, but the deposits are mere incrustations on the surface of the ground and were formed by the evaporation of water that had dissolved them in the ground. Research has so fair failed to show that any alkali lakes or deposits in Montana contain enough potash to make its extraction profitable.

Fluorite or Fluor Spar. Calcium fluoride is of medium weight and hardness. Crystallizes in cubes but it is usually found in massive purple aggregates associated with gold. Fluoritic gold ore occurs at Maiden and often assays hundreds of dollars a ton. It was probably formed by the action of hydrofluoric acid on limestone.

Oxides.

Quartz, silicon dioxide. Harder than steel and two to six times as heavy as water. It crystallizes in 6 sided prisms that usually terminate in rhombohedrons that resemble pyramids. It occurs in many of the igneous rocks, in most metal deposits and as sand and standstone. It is usually grayish white in color. Quartz has glassy luster and conchoidal fracture. Agate, flint and petrified wood are some forms of quartz. Petrified wood results from a slow replacement of wood in the earth by quartz carried there by ground water. The wood itself is not changed to stone but is carried away very slowly and the quartz replaces it.

Cuprite, cuprous oxide occur in small quantities in copper deposits in the Judiths. It is heavy, red in color and earthy in appearance.

Corundum, aluminum oxide occurs in the form of **Sapphire,** at Yogo, int the Little Belt Mountains. The sapphires are almost all blue, but sometimes are whitish or yellow. Sapphire is next to the diamond in hardness. It is infusible and insoluble and has a Sp. Gr. of 4. The crystals are flat prisms and rhombohedrons. They occur in a dike of dark igneous rock which is the chief source of sapphires in the world. Most of the "sapphires" picked up in the surface gravels of Fergus County are quartz.

Hematite, iron oxide occurs in Fergus County in the gold mines in

the Judiths and Moccasins and in red sandstone bluffs, etc., where it has resulted from the oxidation of pyrite and perhaps other iron minerals. It is massive or earthy with a red streak, and yellow, red or brown in color. Often forms a gossan to copper deposits. A large hematite deposit occurs on Woodhurst Mountain and on Wolf Creek, in the Little Belts.

Pyrolusite, manganese dioxide, is a soft black mineral. It occurs in small quantities on the Sutter claims on Armells Creek, and on Wolf Creek, in the Little Belts, associated with pyrite and galena. **Manganite**, which is a hydrated form of manganese, may also be present.

Limonite. The hydrated oxide of iron occurs in the mines of Maiden, Gilt Edge and Kendall. It is brownish in color with a yellowish streak. Springs emerging from red sandstone and igneous rocks often have dissolved iron which they deposit as limonite or bog iron ore. Small plants called algae probably assist this process. Many small deposits have resulted about Lewistown and elsewhere and a large deposit is found on Armells Creek which might possibly be of economic importance.

Magnetite, Fe_3O_4, occurs in small quantities in some of the igneous rocks of Fergus County but has not been found as an important mineral.

Carbonates.

Calcite, calcium carbonate, is one of the most common minerals in Fergus County. Crystallizes most commonly in rhombohedrons, six-sided prisms and six-sided pointed pyramids. The mineral shows perfect rhombohedral cleavorage. It is easily scratched with a knife and so differs from quartz, which it somewhat resembles. Its color is white, gray, yellow, black or brown and it may be either opaque or transporent. Transparent varieties exhibit the phenomenon of double refraction of light. Calcite occurs as small stalactites and stalagmites in caves, as small veins filling cracks in limestone, sandstone and in round iron bearing concretions found in shales. Limestone is massive calcite and often is formed from coral and other shells and is a very common rock in all the mountains. Travertine or calcareous tufa is deposited from hot springs. A great thickness of travertine was deposited after the upheaval of the mountains of Fergus County but still thousands of years ago on top of Gilt Edge Hill and McDonald Creek Divide, in the "Park," south of the North Moccasins, and elsewhere. A deposit of marl resulting chiefly from the decay of small snail shells occurs in Crystal Lake, in the Snowy Mountains.

Dolomite, the carbonate of calcium and magnesium, composes a very small part of ancient Paleozic limestones in the mountains. The carboniferous limestone contains practically no magnesium, and hence it is well suited to make lime and cement. Dolomite is a little harder than calcite, but otherwise resembles it.

Smithsonite, the carbonate of zinc, occurs as incrustations on spalerite and as honeycombed masses known as "dry bone ore." It is of small importance.

Strontianite, the carbonate of strontium, occurs apparently as a replacement of limestone in the foothills of the Big Snowy Mountains, near Cottonwood Creek. The mineral occurred in sharp radiating crystals. It is a little harder than calcite and whitish gray in color. It is thought the deposit is too small to be of commercial importance.

Cerussite, lead carbonate, occurs as a decomposition product of galena in the Judiths and elsewhere. It is of small importance in Fergus County. Many hundred tons of lead carbonate ore carrying silver values

have been produced from the Woodhurst mine, Running Wolf Creek, in the Little Belts. A little anglesite, the lead sulphate, may be mixed with the carbonate.

Malachite and Azurite, green and blue, respectively, hydrated carbonates of copper ore are important surface indications of copper deposits in the Judith and Belt Mountains. Both have been shipped as ore from Armell's Creek in the Judiths and Wolf Creek in the Belts. Malachite is green and occurs in fibrous radiating structures. Azurite is blue, and often occurs in radiating spherical groups. Both are a little harder than calcite.

Silicates.

Feldspars—Orthoclase, the potassium aluminum silicate is a very common constituent of the igneous rock or "porphyry" of Fergus County. It forms perfect monoclinic crystals which are roughly rectangular and are often twinned. Large crystals sometimes over an inch across occur in the Judiths, Belts and Moccasins, especially near the Spotted Horse mine, near Maiden. The crystals are pale yellow or brown. Hardness about the same as steel and softer than quartz. Plagioclase, the sodium calcium aluminum silicate, occurs in the igneous dikes, sills and laccoliths of Fergus County, but seldom in well formed crystals. High potash feldspars are common, as at Square Butte, and may serve as a source for potash if methods are perfected to extract it from igneous rock.

Pyroxene and **Amphibole**, dark colored calcium magnesium, iron silicates occur in the basic rocks of Fergus County but seldom form prominent crystals. Hornblende is the most common amphibole, and occurs in dark green and black, sharp pointed and blade-like crystals. Pyroxene is often common in the igneous dikes and intrusive masses in the Little Belts, but is not the dominant mineral.

Garnet has about the hardness of quartz. It occurs near the contact of limestone and intrusive porphyry in 12-sided crystals (dodecahedrons), as at Ruby Gulch, in the Judiths, and near Yogo, in the Little Belts. The common garnet found in Fergus County is a calcium aluminum iron silicate of no commercial importance.

Topaz, a complex aluminum silicate containing fluorine, has been found in the West Kendall mine, in the North Moccasin Mountains. It occurs in a mineral deposit of galena and gold near the contact of limestone and granite porphyry. It probably results from pheumatolytic action. The topaz occurs in clear, translucent masses, seldom in crystals. It is next in hardness to sapphire and has been cut into very handsome gems. In color the topaz is whitish to yellowish brown and may be either opaque or transparent. Some of the so-called topaz is probably quartz.

Mica—Both the white mica, muscovite, and the black mica, biotite, occur in the porphyry intrusions of Fergus County in the various mountains as fine specks and slender foils, so as to produce a speckled appearance, but they do not occur in commercial deposits. Mica is a very complex silicate, soft enough to be scratched with the finger nail. It resembles flakes of gypsum, but if bent it is elastic, while gypsum is brittle. It splits easily into thin sheet.

Kaolinite, or china clay, a hydrous aluminum silicate which results

from the weathering of felspars, occurs in the soil of Fergus County, but not in pure deposits.

Small amounts of **apatite,** the calcium phosphate containing chlorine and fluorine, exists in the igneous rocks of Fergus County mountains, but no deposits of phorphate rock have yet been found.

Chrysocolla, a hydrated silicate of copper, occurs on Armells Creek, in the Judiths, and on Wolf Creek, in the Little Belts, associated with azurite and malachite. It occurs in small light blue masses and is the result of the ozidation of copper sulphides. It has been shipped to smelters as a copper ore to a small extent.

Vanadinite, a complex vanadium salt of lead, has been found in well formed crystals in the old Sir Walter Scott mine, in the Little Belts.

Olivine, a magnesium iron silicate, occurs in many ingeous rocks in the Little Belts in small irregular masses.

Chlorite is reported by Pirsson to be a constituent of some igneous rocks in Fergus County.

MAIDEN CANYON.

CHAPTER IV.

Geology of Fergus County.

The rocks exposed in Fergus County range in age from early Paleozoic to recent in an almost complete geologic section and aggregate nearly two miles in thickness.

Archean gneises and schists are found near Neihart, in the Little Belt Mountains and probably underlie all of Fergus County as the basement complex on which the later sedimentary rocks were deposited, but none are exposed at the surface. In the Belt Mountains is a great series of shale, limestone and quartzite about 4,600 feet thick, called the Belt Series that is of Pre-Cambrian age. None of these rocks are exposed in the Judith or Moccasin Mountains, but they are well exposed on the South Fork of Judith River, in the Little Belt Mountains, where about 1,000 feet of gray shales have been deeply trenched by the streams. There is about 200 feet of gray, green and black shale exposed in the canyon of Swimming Woman Creek, on the south side of the Big Snowies, in Musselshell County which would represent the top of the Belt Series. In both cases they are overlain by the hard basal sandstone of the Cambrian which is a resistant rock, and forms rock terraces or plateaus.

The base of the Cambrian is named the Flathead and consists of a redish sandstone, usually a conglomerate containing rounded pebbles of quartz. Its base is a true quartzite. The Flathead is 100 feet thick. It is exposed in South Fork, of the Judith River, in the Little Belts; in Swimming Woman Canyon, in the Big Snowies, and at Black Butte. The quartzite is overlain by 150 feet of dark gray or green micaceous shale, with some concretions containing fossils, identified by Wolcott as Middle Cambrian. The shale is followed by a limestone conglomerate. Next there is about 40 feet of yellow sandy shale capped by a thin bedded, flaggy limestone, often containing chert pebbles. It weathers as cliffs and commonly shows well developed joints, so that it breaks into blocks and prisms. The Cambrain is completely exposed around Half Moon Pass, in the Snowies, where it forms great cliffs. The Cambrian occurs in canyons of the Judith River, in the Little Belts; at Black Butte, in Alpine Gulch, Ruby Gulch, and Limekiln Gulch, in the Judiths; in the northeast part of the South Moccasins, and a few small outcrops in the North Moccasins. The Cambian shales and fissile limestones are common zones of intrusion for igneous rocks in the form of laccoliths, sills and dikes. The laccoliths of the Judiths and Moccasins intrude the Cambrian and often the Cambian sales and limestone are tipped and broken into great blocks by the intrusions, as near the Spotted Horse mine at Maiden and on the north side of the South Moccasins.

Between the Cambrian and Carboniferous formations is found about 200-300 feet of limestone that differs in appearance from the conglomerate limestones of the Cambian or the massive thick bedded Madison limestone. The exact age of the formation is a matter of dispute, but it is considered the equivalent of the Siluro Devonian formations of the Three Forks region, which comprize the Jefferson limestone and Three Forks shale. The basal limestone generally rises abruptly from the Cambrian shales as a cliff. The limestone is dark brown to steel gray or bluish black and occurs in beds a few feet thick that are well jointed. The rock frequently has a decided granular appearance due to cream colored markings. It sometimes has a fetid odor when struck with a

hammer, due to the presence of organic matter. Corals and crinoids are found in the limestone. Some beds of sandy shale occur with the limestone. The Siluro Devonian is well developed in the Little Belts, especially in the valley of Lost Fork of the Judith, where it forms the greater part of the bedrock. It forms the tops of the ridges about Alpine, New Year, Ruby, and Limekiln Gulches, in the Judiths. It is a common rock in the Big Snowy Mountains and outcrops in the Moccasins.

The most characteristic formation in the mountains of Fergus County is the Madison limestone of Lower Carboniferous or Mississippean age. This consists of thick bedded limestone towards the base and very massive limestone at the top. The formation varies from 750-900 feet in thickness. The limestone is often stained brown or yellow by iron oxide and gold and other metals occur as replacements of the lime along its contact with intrusive sheets of porphyry in the Judiths, Belts and North Moccasins. Caves, arches, sinkholes and pinnacles are common phenomena of the weathering of the limestone. The rocks resist erosion and often stand as nearly vertical cliffs several hundred feet high. Deep, narrow "box canyons" are a characteris of its erosion where its strata dips moderately, and forms the gateway to the mountain in most of the canyons. The Madison is much more resistant to erosion than any overlying rocks and therefore usually serves to sharply separate the mountains from the plains and foothills about them, and therefore is called the "mountain limestone." The limestone is light colored and in the upper portion dense, rarely crystalline, and contains some small masses of chert. It is pure and is used for the manufacture of lime and portland cement. The Madison outcrops over the greater part of the Big Snowy and eastern extension of the Little Belt Mountains, and forms a wide belt around the Moccasins and most of the Judith Mountains.

Above the Maadison limestone the Quadrant formation occurs which is commonly considered of Upper Carboniferous or Pennsylvania in age but the writer considers the top of the formation, at least, to be the equivalent of the Permo-Carboniferous or "Red Beds" of the southern Great Plains. The Quadrant is a very variable formation. It is 1,400 feet thick near Utica, over 1,000 feet at Alaska Bench, 700 feet of it were penetrated in an oil well near Piper, while only a few feet of shale represents it in the Judiths and Moccasins, while it is lacking entirely in the Little Rockies, north of the Missouri. No unconformity between the Madison and Quadrant has been found, but the character of the rocks changes entirely. The base of the formation near Judith Gap consists of red shale, but at Alaska Bench and in the Piper well, thick beds of hard sandstone was encountered in this horizon. Above this there is about 100 feet of coppery green shale, which perhaps is the most characteristic member of the lower half of the formation. Thin beds of bituminous limestone occur both above and below the green shale and are especially well developd on Alaska Bench, where they are associatd with over 300 feet of black shale. A hard siliceous limestone that weathers red on exposed edges and contains many fossils forms the top of the formation around the Big Snowy Mountains. This limestone is over 150 feet thick at Alaska Bench and only 18 feet thick a few miles north at Piper, and is absent a few miles farther north in the Judiths. From a study of fossils collected by Calbert, Girty states (Bull. 390 U. S. G. S., pp. 8-19) he is unable to correlate the formation exactly as some fossils are characteristic of the Pennsylvanian and others suggest late Mississippean. The

hard limestone beds of the Quadrant are resistant to erosion and form the top of Alaska Bench and other high benches east and north of the Snowies, which all have a steep inner slope towards the mountains and a gentle outward slope with the dip of the hard rock away from the mountains. The underlying shales of the Quadrant are easily eroded and form broad passes and valleys between the Madison limestone of the mountains and the foothills and benches around them.

The Triassic beds of Wyoming appear to be absent in Fergus County, as the Jurassic system of rocks lies upon the Quadrant. The Jurassic consists of the Ellis formation and the Morrison formation. The Ellis beds consist of sandstones, thin limestones and dark colored shale. The sandstone is conglomeratic and usually contains a great number of oyster shells, and weathers to a peculiar tan color. The Ellis varies greatly in the character of its strata in different places. Limestone is sometimes almost absent, but at Button Butte it is thick and hard. Thick beds of pure gypsum occur in the Ellis around the Snowies and at Hanover. The top of the formation is sandstone, which serves to separate it from the overlying Morrison formation whose basal member is shale or shaly limestone. The Ellis is about 400 feet thick, but there is considerable variation in different localities. The Morrison averages about 125 feet thick, and consists mostly of vari-colored shales. The base consists of red and pink shale which gies way to greenish shale and finally to buff sandstone at the top. The layers of siliceous limestone that often contains calcite crystals are interbedded with the shale. The peculiar vari-colored shales are the most interesting lithological characteristic of the Morrison. The Morrison is here classed as Jurassic but may represent the base of the Cretaceous.

The strata of the Cretaceous system cover most of the surface of Fergus County outside of the mountains and foothill regions. The Lower Cretaceous is represented by the Kootenai formation. The Kootenai varies from about 450-550 feet in thickness, and is made up of alternating layers of shale and sandstone and in some places beds of good coal occur. The shale is of a clayey character and is predominantly reddish. The sandstone members vary greatly in thickness within short distances. They usually show cross bedding and are conglomeratic and are stained red and yellow by iron. The best coal beds sometimes are present higher up in the formation, but they are usually thin and of poor grade. Springs commonly occur at the outcrop of sandstone and coal beds. A film of iron hydroxide often forms over the spring water, which has an iridescence similiar to oil and such springs are sometimes mistaken for oil seepages. Many of the springs are depositing bog iron.

The Colorado shale overlies the Kootenai with apparent conformity, but farther east, in the Great Plains, several hundred feet of strata occurs between similar formations. In Fergus County the formation is from 1,500 feet to 2,300 feet thick. Above the Kootenai is about 100 feet of alternating fine-grained sandstone and thin layers of shale, both of which weather brown. The sandstone is often in the form of flat lenses, The remainder of the formation is shale that varies in color from dark gray and drab to black. The shale contains occasional thin sandstone members. The Colorado outcrops very extensively in Fergus County and is the bedrock through most of the Judith Basin. It covers the county

between Gilt Edge and Grass Range to Winnett north to about the line of Box Elder Creek and Black Butte.

The Colorado is overlain in Central Montana by the Montana group. The Montana consists of the Eagle sandstone at the base, followed by Clagget formation, the Judith River formation and the Bearpaw shale in order. The Eagle is 200-300 feet thick and consists of 120 feet of heavy bedded sandstone at its base which varies from white to buff and brown in color. Above this are thin beds of coal and carbonaceous shale. The Claggert shale is of marine origin and is usually black in color. It resembles the Bearpaw shale, except toward the top, which contains thin beds of sandstone. The Clagget is about 700 feet in thickness and is 250-500 feet thick. The Judith River consists of sandstone usually cross bedded that weathers to a peculiar yellowish color, and alternates with clay and shale. In Northern Fergus County there is a persistent bed of coal and carbonaceous shale which usually changes to fairly good coal. This is usually overlain by several inches of oyster shells (Ostrea subtrigonalis) which form a clearly defined bed. The formation contains bones of vertebrates and much petrified wood. The Bearpaw shale is about 1,100 feet thick and is predominately black in color. It frequently weathers to form extensive gumbo flats. The shale contains many round and oblong concretions which are filled with fossils, especially ammonites and belemites. The Montana formations outcrop over almost all the county north and east of the areas covered by the Colorado shale. This includes the country east of Winnett to the Musselshell and north of Black Butte, Hilger and Deerfield to the Missouri.

In Northeastern Fergus the Lance formation of Tertiary age occurs over the Bearpaw shale. It consists of alternating beds of gray sandstone and clay shale with thin beds of coal near the top. It is a more resistant formation than the Bearpaw and caps Dovetail Butte and others along Crooked Creek. It covers considerable areas around Valentine and in the triangle between Box Elder Creek, the Musselshell and the Missouri.

The Quaternary system is represented by valley deposits of alluvium along the chief rivers, by spring deposits of travertine near the laccolithic mountains and by terrace gravels covering most of the great benches in the Judith Basin. The alluvium occurs mainly in the valley of the Missouri and Musselshell. The travertine or calcareous tufa caps Gilt Edge Hill and covers extensive areas on McDonald Creek Divide south to the road from Heath to Forest Grove. It caps Castle Butte, and two buttes at the northeast and southeast corner of the South Moccasins, and covers several sections in the plateau called the "Park" at the southern edge of the North Moccasins. The travertine consists of limestone deposited from great extinct springs which derived it from the neighboring mountains and is porous and often silicious. It is deposited on the truncated edges of folded Jurassic and Cretaceous formations showing that the country was base leveled before the deposit began. The gravel was brought from the surrounding mountains by ancient meandering streams and probably also by floods. The Basin was evidently nearly at base level and the gravel was deposited on gentle slopes from the mountains to the Judith River. Later the streams renewed their downcutting and carved valleys far below the old slopes and made the bench of the Basin of today. Three and in some places four or five gravel covered benches or terraces along the chief streams can be identified, each of which indicates

that the stream flowed at that level for a long time. The gravel consists of water worn limestone, quarzite and porphyry from the mountains and is from a few feet to over 50 feet thick. The gravel surface is level but was deposited on irregularly eroded bedrock. The gravel resists erosion better than the shale, which it usually covers, and is the cap rock for most of the buttes and benches in the Basin. Locally lime deposited by ground water has cemented the gravel together and formed a gravel cement. A few granite, gneiss and schist boulders are thinly scattered over Northeastern Fergus County and were brought from Canada by the continental glacier that came from west of Hudson Bay some 50,000 years ago. The glacial deposits are unimportant and weathering and erosion have removed all but the hardest rocks.

GEOLOGICAL HISTORY.

The sedimentary Belt Series was deposited unconformably on highly metamorphic gneisses and schists in Central Montana. The thick Pre-Cambrian Belt Series of marine shales and limestone indicates that an ocean covered Central Montana for a very long time. There seems, however, to have been an island near Neihart. The Pre-Cambrian closed with a great uplift and this area was dry land for an unknown length of time. The uplift was not high enough to result in much erosion, however, as there is no angular unconformity betwen the Belt Series and the Cambrian, the basal conglomerate of the Cambrian indicates a sinking coast and an ocean advancing over the land. The shale and limestone overlying the conglomerate indicates a steadily deepening arm of the ocean. Then for millions of years during Silurian, Devonian and Lower Carboniferous times Central Montana continued to be covered by an ocean. There was evidently no land areas nearby as almost pure limestone was deposited over 1,000 feet thick. Fossils indicate that the climate was warm, even almost tropical at this time. Many fossil coral reefs occur in the mountains and corals die when the temperature drops below 65 degrees F. The rocks at the base of the Quadrant indicate a shallowing of the ocean and much of the formation is characteristic of brackish water and shore lines. The great variation in thickness of the Quadrant indicates variable distances from land masses. An uplift closed the Quadrant, as the Ellis in Cascade County, lies on the Madison, but no erosion sems to have occurred in Fergus County, so that the land was not much above sea level. The Ellis beds of Jurassic age were deposited in the ocean, but its sandstones are a sign that the water was stagnant. The fossils in the Morrison are fresh water forms and its sandstones are cross bedded, both proofs that the Ellis closed with a withdrawal of the sea and that the Morrison is a terrestial deposit. The climate was probably arid in part of early Jurassic times during which thick gypsum beds were deposited in lagoons. The gypsum is accompanied by marine limestone showing that a minor inundation of the ocean occurred. The land soon rose and the marine part of the Jurassic was succeeded without apparent unconformity by cross bedded terrestial sandstones and shales of the Morrison containing fresh water fossils.

Central Montana continued to be land through lower Cretaceous time as the cross bedded sandstones and coal beds of the Kootenai indicate river and wind deposits and swamp conditions favorable for the growth of coal making plants. The ocean, however, again returned and covered America from the Gulf of Mexico across Montana to the Arctic Oceon.

The great thickness of the Colorado shale shows that the ocean covered Fergus County for a long time. The Eagle sandstone indicates a shallowing of the water and a return to the swamps and shore line conditions. The Claggett shale was deposited in a renewed flooding of the land by the ocean which, however, later withdrew out of Central Montana for thousands of years, during which the coal beds, cross bedded sandstones and terrestial clay of the Judith River's formation were deposited. The ocean continued to cover Montana east of the Musselshell as the Judith River beds thin out and disappear in that direction and the Claggett and Bearpaw are not separated but are one formation. The ocean covered Fergus County for the last time when the Bearpaw shale was depositd. The Lance is a formation deposited on the land or in shallow fresh water. Cretaceous time was closed by probably the greatest uplift that has occurred in this part of Montana and in the early tertary intrusions of igneous rock domed up the Judith and Moccasins and compressions of the earth's crust produced the great anticlines of the Snowies, Belts and South Eastern Fergus County. Ash beds occur in the upper Cretaceous rocks near the Highwoods, showing that the volcanoes there were then active. The dikes that radiate out from the Highwoods and also occur along the Missouri were intruded at this time. Since the close of the Cretaceous erosion has removed thousands of feet of sedimentary rocks, the travertine and bench gravels were deposited during this time. Erosion processes have been periodically renewed in Fergus County and there were long intervals when more deposition than removal of sediments occurred. Some 50,000 years ago a glacier covered Northeastern Fergus County but left no important deposits. The great gorge of the Missouri and the lesser valleys of its tributaries inside the last broad terrace have been cut since then.

COMBINE AT WORK.

CHAPTER V.

Metal Deposits of Fergus County and Their Development.

Over $18,000,000 worth of metals, mostly gold, has been produced from the mines of Fergus County. Several descriptions of the mining districts have been published and are listed in the bibliography. They were of assistance in the preparation of this chapter, but all mines have been visited and new data collected. So far as possible complex and theoretical discussions are avoided in the discussion of the metallic resources in this chapter. Those wishing further descriptions of the mines and mineral deposits are referred to the reports listed in the bibliography.

Gold was first discovered in Fergus County in 1870, at Yogo, in the Little Belt Mountains. A rush ensued, and soon 1,200 miners were busy working the placers and quartz lodes. The claims proved disappointing and the town was abandoned.

Placer gold was found in Alpine Gulch, in the Judith Mountains, in 1880, and the Spotted Horse and Maginnis mines were located the same year. Prospecting or mining has been active in all the mountain groups of the county since the discoveries at Maiden.

Placer gold occurs and is apparently mostly derived from the weathering and erosion of small pyritic gold bearing veins in porphyry. Gold has been produced from placers in the Judith Mountains, chiefly in Alpine Gulch and Armells Creek, from the Little Belts in Yogo Gulch, and from the North Moccasins in the gulches of the south half of the mountains. Deserted cabins, old flumes and piles of worked over grovels and rock remain in several of the gulches to mark the activity of the placer miner, but it is improbable that the total production ever amounted to over $100,000. Only a few ounces have been reported in the last ten years.

Quartz deposits of metals in Fergus County are of two types. The first type consists of small stringers and veinlets in intrusive porphyry, especially near phonolite dikes. No important mine has ever been developed from such deposits although high assays of gold, silver, lead and copper are sometimes obtained, and some ore has been marketed. At times the phonolite dike itself contains enough mineral to be called a "vein of ore." The small pyritic veins in porphyry have supplied most of the placer gold. Such veinlets are found in the North Moccasins, near Yogo in the Belts, and in the Judiths in Alpine Gulch, Grassy Peak, Red Mountain and the Cone Butte mining sections. Two small stamp mills were built many years ago in the North Moccasins in an attempt to work the pyritic veins, but the gold content was too small to permit its profitable recovery. Similar failures have resulted in the Judiths. However, it is not improbable that rich pockets of shipping ore may be found in some of the veins in the porphyry, although from the experience of the past it is not probable that any large ore bodies will be discovered under such circumtsances.

The second type of metal deposit are ore bodies formed by the replacement of limestone near its contact with intrusive laccoliths and sheets of igneous rock. These deposits have furnished nearly all of the metal production of the county. The mines developed from this type of metal deposit are valuable for (1) gold, (2) lead-silver and zinc, (3) copper. They will be described under the head of the mountain group or mining district in which they occur.

The replacement deposits in the mountains were deposited at depths

of several thousand feet, or at what Lindgren calls intermediate depth. It is probable that some or bodies are not exposed at the surface at all, as such exposure results from the accidental processes of erosion. The manner of occurrence, the kind of minerals, and the banded structure of many of the deposits indicate a deposition from hot escending solutions. Nearly all the metals seem to have been originally deposited as sulphides, but since their formation they have been oxidized to depths of several hundred feet. The most valuable ore bodies are replacement deposits of gold in limestone near its contact with intrusive igneous rock. If the ore is near a sheet of porphyry it is always underneath it and the porphyry serves as the hanging wall. The ore deposits usually occur in well defined shoots, although some of them are irregular and assays are necessary to tell ore from unmineralized lime rock. The richest ore at Maiden is accompanied by purple fluorite. The fluorite resulted from the action of hydrofluoric acid on limestone. This acid was probably brought by solutions from the intrusive molten magmas and may have aided in dissolving the gold. The gold-bearing limestone is usually siliceous, often jasperoid and is more crystalline than before mineralization.

It is believed that the mineral bearing solutions were derived from intrusive igneous rock and were therefore hot. They were ascending as they occur below porphyry sheets. The contraction of the molten magma on cooling would leave fissures through which solutions might pass. The chief ore bodies occur in thin bedded and easily fractured limestone towards the top of the Carboniferous. The thick bedded Madison limestone below and the sandstones and shales of the Jurassic above have been little affected. Solutions easily entered along the bedding planes, and the fissures resulting from the uplift of the mountains and intrusions of igneous rock. Solution of limestone was very extensive as great deposits of travertine are found near the Judith and Moccasin Mountains. The precipitation of minerals in the brecciated limestone would be caused by: greater solubility of limestone, relief of pressure, lower temperature, and chemical reactions, due especially to the presence of carbonaceous matter that would act as a reducing agent. The effect of carbon is best shown in the Barnes-King mine, where the best ore contains so much carbonaceous matter that roasting is necessary before cyanidation. This ore assays $20-$30 per ton while the average from the mine is about $8. The gold probably was originally deposited as a telluride, along with quartz, calcite and sulphides, especially pyrite. Surface waters and the air have oxidized the pyrite which results in staining much of the ore a red, yellow or brown color, and practically all ore mined is softened and decomposed by the agents of weathering. Free-gold is rarely seen.

MINE DESCRIPTIONS.

Judith Mountains.

The most important mines are those near Maiden. The Spotted Horse was located in 1880 and was operated fairly continuously by different parties until 1902, when it was closed. It was reopened in 1912 and ran until 1917, not operating in 1918. During this time the mine was operated by E. B. Coolidge under lease. The Spotted Horse has produced about $5,500,000 in gold. The ore during its first period of operation was all shipped to the smelter and averaged about $100 per ton. Much of the ore was high grade, some being worth $30,000 per ton. The best ore is colored purple by fluorite. The mine is developed to a depth of 585 feet

with appropriate levels. It is equipped with a 75-ton cyanide mill and most of the gold produced in recent years has been recovered from low grade ore. The ore occurs in very perfect shoots underneath inclined sheets of porphyry. The mine is not worked out and the geological conditions are such that further ore bodies may be expected to occur. Four chimneys of ore have so far been worked.

The Maginnis mine was located in 1880 and worked at intervals until 1899. It was then closed until 1909, and since then has been operated periodically by lessees. The Maginnis has produced about $2,000,000 in gold. The mine is developed to a depth of 426 feet with over a mile of drifts. It is equipped with a 10-stamp mill, a concentrator for shipping ore, and a cyanide plant for low grade. Much quartz and purple fluorite ore averaging $100 per ton has been shipped to the smelters. The ore bodies occur beneath sheets of porphyry and is thought they should continue to a greater depth than has yet been mined.

The Cumberland mine adjoins the Spotted Horse. It has produced about $500,000 in gold. It is developed with a 1,000-foot adit and is equipped with a 150-ton cyanide mille. The ore occurs at the contact of limestone and porphyry. Two hundred and seventy thousand dollars came from workings above the adit which exhausted the ore body. The mine was leased and early in 1916 a big ore body was opened and in 1916 and 1917 a large tonnage of high grade ore was shipped to the smelter and some lower grade sent through the mill. The mine was closed in 1918 as a result of the lessees joining the army.

The War Eagle, near Maiden, is developed by a short tunnel. Since 1910 several shipments of zinc ore carrying values in gold, silver and lead have been made.

A large amount of prospecting has been done near Maiden, and several of the prospects may turn into mines with further development work. Alpine Gulch and Grassy Peak contain prospects where high assay values have been secured. Some of these claims are lead, silver, others copper, or gold. The Florence has been closed for yars, but produced gold for a time from a small but very rich ore body from which 17 tons yielded $9,000.

The Cone Butte mining district includes the Judiths, north of Maiden. No large mines have been developed within this section, but much prospecting has been done and there are many likely prospects. Those on Red Mountain and vicinity are of the vein type in porphyry. Those farther down the slopes of the mountains are near the contact of lime and porphyry.

Considerable mineralization occurs on West Armells Creek. Several pockets of lead ore have been found as replacement deposits in limestone. The Cave mine produced several thousand dollars worth of lead-silver ore from such a pocket. Ore from these pockets has sometimes been concentratd in hand jigs before sacking for shipment. On the floor of Armells Creek Canyon is a surficial bed of limonite (bog iron ore) deposited from iron springs. Many thousand tons are exposed but it is unlikely that it will have any value in the near future. The Sutter Copper Prospect is on the ridge between two forks of Armells Creek. The property is developed with a short tunnel and a winze 30 feet dep. The property appears to be of the contact metamorphic type. Limestone overlies porphyry at this place and the porphyry is covered with a pronounced iron cap which shows green and blue copper stains in some places and considerable evidence of leaching. Further development would seem to be justified, as

from the evidence visible it seems probable that secondary enrichment may have occurred, in which case a profitable ore body would result. Two carloads of ore running 10-15 per cent copper was shipped in 1917. The ore was oxidized and consisted chiefly of azurite, malachite and crysocolla. Litigation has delayed development. There are other copper claims on Armells creek from which some ore has been found. They all lack development. On the north side of Armells Creek, not far above the stream, heavy sulphides, said to carry gold, have been found in a short tunnel near a lime contact. Traces of manganese occur on Armells Creek.

The Copper King group on Red Mountain is developed with a short tunnel and some 2-3 per cent copper ore has been found. The Cone Butte mine is developed with a shallow shaft, and some very good assays have been obtained. It has not been worked for several years. On Elk Mountain there are sevral small lead-silver properties from which small amounts of ore are sometimes shipped. There are a large number of prospect cuts, tunnels and shallow shafts in the Cone Butte district. Assays have been secured varying from a few cents to thousands of dollars a ton. In general, consistent work has not been done by miners and prospectors in the Cone Butte section and the presence or absence of profitable ore bodies remains to be demonstrated.

Claims were located at Gilt Edge in 1884 and 1885 by William Wilson ("Limestone Bill"), Anderson and Munson. The ore is low grade and is of the limestone replacement type. Limestone that is gold-bearing is siliceous and generally stained with iron oxides. It contains no fluorite. Ore bodies usually occur near the contact of porphyry and lime, and the best ore was found in the soft thin-bedded upper Carboniferous limestones under sheets of porphyry. The porphyry is sometimes altered and itself forms ore. The Gilt Edge mill was among the first in the United States to apply the cyanide process for the extraction of gold. The process was not well understood at first and considerable gold was lost in the tailing. For several years following 1898 a large production annually came from the Gold Ref and Great Northern properties. During this time an efficient 300-ton cyanide mill extracted about $1,250,000 in gold from the ore. The mill was dismantled several years ago, but the last two years a small cyanide plant was erected which has successfully retreated the tailings from the old mill.

The Whiskey Gulch mine has a 100-ton cyanide mill and produced $165,700 in 1903-1904 from $5.50 gold ore. It has since been closed, but considerable low grade ore is said to be in sight. The Mammoth is equipped with a 100-ton cyanide plant, but has produced little gold. Prospecting has been done on the Mammoth and other nearby claims recently. Some lead ore has been mined near Gilt Edge, but part of it contained too much zinc to make shipments profitable, as lead smelters penalize ore containing zinc since it interferes with their methods of smelting.

Claims were located in New Year Gulch in the early 80's, but although much money has been spent on development work the production has been small. The values are in gold and the ore occurs as replacements of limestone underneath sheets of porphyry. The New Year has a cyanide plant of 150 tons capacity and is connected with the mine workings by an aerial tramway. Little ore was found in the New Year. The Gold Acres property adjoins the New Year. In 1915-1916 an 800-foot adit and drifts were driven on this property without disclosing any milling ore. Finlaw

and Allister have claims close by and have developed some ore suitable for cyanidation.

North Moccasin Mountains.

Claims were located in the North Moccasin Mountains in the early eighties. Two small stamp mills were constructed to work small pyritic veins in porphyry but the gold content was too small for profit and little remains of the mills today. Small placers were worked at intervals for many years, but their total gold production is not large. The real development of the Kendall mines commenced in 1898.

The Kendall mine was the first to be developed in the Moccasins. Harry Kendall purchased the original claim from Charles Allen for $650 and the adjoining Klondike for $1,500 from Ira Knapp and A. B. Hopkins. He built a small mill to treat the ore and in November, 1900, sold the mine to the Finch interest of Spokane for $400,000, receiving $360,000 cash and 1-10 interest in the mine. A 500-ton mill was built and a shaft was sunk to a depth of 620 feet and a power plant constructed on Warm Spring Creek. From May 1, 1901-1912 the Kendall produced $3,741,364.58 from 775,686 tons of ore. The Kendall was capitalized for $2,000,000 and paid $1,555,000 in dividends. To avoid threatened litigation the Barnes-King bought the mine and other property for $100,000 early in 1917. The last four years the mine has been operated under lease, and from June 1, 1915, to December 31, 1918, $98,409.02 was recovered from 39,923 tons of ore. The low grade ore has come entirely from a big open cut and an output is maintained of several thousand dollars a month, except when heavy snow interferes with mining. The ore body of the Kendall is generally elliptical in shape but with irregular boundaries and sometimes is over 300 feet in diameter. It occurs at the contact of a dike of rhyolite porphyry and limestone. Both lime and porphyry have been replaced by gold and form ore. The size of the ore body decreased in depth and is believed to be worked out except near the surface.

Claims were located on replacement deposits in limestone to the north of the Kendall mine as early as 1887 by Barnes, Wunderlin, Woodman and King. They gradually added to their holdings until they controlled over 200 acres adjacent to the town of Kendall. A company composed chiefly of Butte people, purchased the property in 1906. The company was capitalized for $2,000,000. The ores proved low grade and the company made little profit, although a total of over $1,500,000 in gold was produced. The mine was developed by a long tunnel, shaft and drifts, and the old workings exceed two miles in extent. A new management took charge in 1912, reconstructed the 200-ton cyanide mill and abandoned the old workings and purchased the North Moccasin property. The North Moccasin is located between the original Barnes-King and the Kendall and had already produced $250,000 in gold, mostly from an open cut. A shaft on the Santiago claim was deepened to 500 feet with an incline to a further depth, and careful development work disclosed a large ore body. The ore body is of lenticular form. It varies from a few inches to 50 feet thick and in some places is 400 feet wide. It dips steeply at the surface and flattens out below the bottom of the shaft. It has been developed for 1,200 feet on the dip. A large part of the ore body is stoped out, from which the Barnes-King has recovered $1,909,935.58 up to December 31, 1918. The ore averages about $8-$10 in gold per ton, of which 90 per cent is recovered. The best grade of ore, worth $20-$30 per ton, was mined below the bottom of the shaft. This ore contained so much car-

bonaceous matter that it interfered with the cyanide process and had to be roasted before cyanidation. At about 1,200 feet on the dip or nearly 700 feet below the surface, the ore body is thin and lower in grade. Most of the ore now comes from the upper levels. Careful assays are necessary to tell the ore from worthless limestone. The Barnes-King ore body dips with the limestone strata and no porphyry is exposed in the workings. The limestone was uplifted by a laccolithic intrusion which was probably the source of the gold-bearing solutions. The flattened strata in the bottom of the Barnes-King mine indicate that the laccolith does not extend far below the town of Kendall. The Barnes-King Development Company has paid dividends of $300,000 up to March, 1919.

The ore body of the Barnes-King occurs in the thin beds of limestone at the top of the carboniferous, and under the Jurassic shales and sandstones. This zone is stained yellow and red with iron oxide in a belt nearly surrounding the Moccasins. Ar great deal of prospecting has been done along this zone by shafts and tunnels and some low grade ore has been found, but no other mines have been developed.

The Golden Discovery was near the Kendall and considerable sums were spent on development work on the property. Some good ore was found but no considerable body of ore was discovered and the property has not been worked for the last decade. Quite a little work was done on the Gold Links near by without profitable results.

The Abbey, north of the old Barnes-King, sunk a shaft some years ago and drifted in on the mineralized zone but found no commercial ore body. The North Kendall, on the north side of the mountains, developed by a tunnel and other workings which cut some low grade gold ore. Development work has been done during the last few years on this property. Considerable prospecting has been done on the West Kendall by tunnels and winzes. Some gold ore and galena has been developed chiefly along the contact of lime and porphyry. Considerable topaz, which cuts into clear transparent gems, resembling diamonds, has come from the West Kendall.

Little Belt and Other Mountain Groups.

Considerable time and money has been spent in the South Moccasins in searching for ore bodies. Claims have been staked on yellow sandstone, decayed porphyry and limestone porphyry contacts. Low grade ore has been found in small stringers in Jurassic sandstone on the south slopes of the mountains, and traces elsewhere.

A prospect of galena and zinc ore was mined on the Hardly Able property in the broad valley between Hanover and the mountains. It is surrounded by shale and sandstone. While a dike and sheet of porphyry are near by, the writer believes that the mineralization in the pockets and fracture zones of the Mesozoic sandstone resulted from precipitation from cool meteoric waters that dissolved the metals from a disseminated form in the porphyry of the mountain mass. The fractures are filled with well formed calcite crystals, so it seems probable that the solutions were cool and had not ascended from any great depth. A capping of shales formerly overlay the sandstone and restricted mineralization to it. No important ore body has been found in the brecciated sandstone.

Prospecting for gold and copper has been done in the Big Snowy Mountains especially in Swimming Woman Canyon. The prospects are located on fracture zones in black and green shale of the Belt Series, which have

been filled with calcite and iron oxide. Nothing of value has been found. A few prospects were located on iron stained limestones, but nothing of value has been found.

Gold was discovered in that part of the Little Belts which are in Fergus County, near Yogo, in 1879, and soon the town had a population of 1,200, but development work failed to disclose important ore bodies and the placers also proved disappointing, hence the old town was abandoned in 1883. Considerable prospecting has been done on the mountain slopes along Dry Wolf and Running Wolf Creeks. Lead-silver ore predominate in this district, and work has ben done on some copper prospects. The ore occurs as replacements in limestone near contacts with intrusive igneous rocks. The ore bodies have usually proved small and pockety, but some rich ore has been mined. The production has amounted to possibly $100,000, of which the Mountainside is credited with $30,000. The Sir Walter Scott, Weatherwax and Woodhurst produced lead and silver ore in the past and a few crystals of vanadinite were found in the Sir Walter Scott. The Yankee Girl shipped several carloads of complex ore of lead, copper, silver, gold and zinc in 1916-1917. An extensive deposit of high-grade hematite occurs on Woodhurst Mountain and smaller bodies of iron ore have been found elsewhere in the Little Belts.

Production.

The total production of metals in Fergus County has been probably over $18,000,000 by the end of 1918, of which the Judiths produced a little more than half. The remainder mostly came from the North Moccasins. The totals are estimated as follows: Judiths, over $10,000,000; North Moccasins, nearly $8,000,000; Eastern Little Belts, $100,000. In addition about $2,000,000 of raw sapphires have come from Yogo and other millions of coal, gypsum, brick lime and cement rock, bringing the total value of the mineral produced in Fergus County to the end of 1918 to nearly $25,000,000.

CATTLE ON THE RANGE.

CHAPTER VI.

Mineral Fuel Resources of Fergus County.

The only developed mineral resource of Fergus County is coal, but there are favorable possibilities for oil and gas, and prospecting for them is in active progress.

Coal.

The Kootenai formation contains almost all the valuable coal, but coal for local use near the Missouri can be mined from the Eagle and Judith River formations. There are indications of coal in the Lance. The carbonaceous shales of the Quadrant and Colorado formations have been prospected for coal at various times, but there are no workable beds in those formations. Millions of tons of coal have been mined at Roundup from Tertiary formations, but this is now included in Musselshell County.

There are three beds of coal in the Kootenai, near its base. The best bed underlies a thick bedded sandstone that forms prominent bluffs and usually the coal can be mined by drifts on the side of the valley. In many places the Kootenai coal is of too poor quality to mine. The best coal is found on McDonald Creek Divide and between Forest Grove and Gilt Edge, on Boyd Creek, southeast of Lewistown up Spring Creek, and at Lehigh. Fairly good coal is mined near Utica and at Saager Canyon, near the Belts, toward the head of Beaver Creek, in the foothills of the Snowies, and in the valley of Warm Spring Creek, east of Brooks. The coal is of poor quality around the Moccasins and at Judith Gap. It is too deeply buried to be mined at present prices in the Judith Basin, west of Lewistown, until an upfold of the strata exposes the coal beds at Lehigh. There are many hundred million tons of coal in Fergus County, and about a million tons has been mined so far and sold for over $2,000,000. Fergus County coal suffers because mining is expensive, due to the thin beds and from competition with the better grade of coal coming from Roundup, Red Lodge and Wyoming. The Kootenai coal is classified as a bituminous coal. Should occasion demand it, the output of coal in Fergus County can be largely increased. It now amounts to about 300,000 tons a year.

Most of the coal mined in Fergus County comes from Lehigh. The Cottonwood Coal Company operates two mines there and is producing 1,000 tons per day which can easily be increased. One mine is a shallow shaft, the other is a drift mine. The coal bed is about eight feet thick, and contains considerable bone and shale. This and the coal dust are removed by washing. The Cottonwood Coal Company operates the largest coal washing plant in Montana where the waste is removed, and carried by an aerial train hundreds of yards away and dumped into a coulee. Several hundred men are employed in the mines. The coal is mostly used by the Great Northern Railway. The company started selling coal from its first mine in 1914 and its drift mine in 1918.

The old Gebo mine, in South Lewistown, produced considerable coal in the past and is still operated in a small way. Other mines up Spring Creek produce several hundred tons a year and are operated at intervals. Good coal is produced on McDonald Creek Divide and many thousand tons are annually produced from several small mines. Their output is hauled to market in wagons. Producing mines include the Black Diamond, Cox, and Weingardts. The Jackman mine, near Forest Grove, ships by

THE FLAT LAND ALONG THE CREEK IS THE FLOODPLAIN OF THE STREAM
THE ROLLING LAND IN THE BACKGROUND IS FOOTHILL LAND, VALUAB
FORMED WHEN THE RIVERS FLO

TOM LAND," EXTENSIVE FLAT ABOVE THE STREAM, A "BENCH" AND GRAZING. THE BENCHES ARE THE BEST GRAIN LAND AND WERE A HIGHER LEVEL THAN AT PRESENT.

rail to Lewistown, as it is located but a few hundred feet from the railway. Mines near Gilt Edge and New Year help supply the nearby ranchers and before the decadence of the gold mining industry the coal was demanded for power by the gold mines. Mines at Saager Canyon, and on Rock Creek and Beaver Creek are work in a small way each year.

A low grade coal occurs in the Judith River formation in parts of Northern Fergus County, but only carbonaceous shale occurs in the Southeastern section. The coal is overlain by a bed of oyster shells a few inches thick that makes a good. marker. The coal will not pay to mine on a large scale, but fuel is scarce owing to the treeless character of much of the country and the coal can be mined by the ranchers for their own use as at Cutbank, east of Winifred. Considerable prospecting for coal has been done along Dog Creek. The Eagle sandstone contains thin beds of fairly good coal between Fullerton and Judith P. O. and near Deerfield, which are capable of small production. There are many faults in Northern Fergus County for 20 miles south of the Missouri. These faults bring the Eagle sandstane and Judith River formations to the surface and makes the coal outcrop more widely than it otherwise would. Unfortunately the tipping of the coal bed makes mining difficult and has caused the coal near the outcrop to slack and weather to worthless material. It is very unlikely. that any coal will be mined in the Eagle Sandstone and Judith River beds of Fergus County except to supply a limited local demand.

Petroleum and Natural Gas.

Petroleum in commercial quantities has not been discovered in Fergus County, but prospecting is actively in progress and an important discovery may be considered possible. Nearly a dozen oil companies have been organized for business in Fergus County, some of which never pass the promotion stage, but wells have been drilled by four of them.

Oil may occur in the rocks under variable conditions, but experience shows that ti most frequently is found when certain geologic requirements are satisfied, and by searching to see if these are present much time and money can be saved on prospecting. First there should be a source for oil and this is generally considered to be formed from decaying plant and animal matter deposited when the rocks were laid down. Oil seepages may indicate the presence of oil but are not a safe criterion in determining if it is present in commercial quantities. Iron hydroxide on water has an iridescence similar to oil, and decaying vegetation in stagnant water liberates gas and oil, sometimes mistaken for petroleum. Oil most frequently is formed in peculiar black shales and bituminous limestone but these are usually too dense to make good reservoirs for deposits of oil. There should be present a porous rock, usually sandstone, to act as a reservoir and this should be capped with an impervious stratum in order that the oil and gas shall not escape. Experience shows that to form commercial pools of oil the petroleum widely distributed in the rocks should be caused to migrate from its source and to accumulate in a limited area. The agent generally believed to cause the migration is water and the oil pools usually collect in anticlines or upfolds of the earth's crust, since oil is lighter than water, and if present in porous rocks rises to the top of the water and collects in the highest places possible. Gas, if present, will be at the top of the anticline, with petroleum below it, and farther down the dip of the rocks.

In prospecting for petroleum the structure of the rocks should first

be studied. An anticline, dome or other upward movement of the earth's crust is not necessarily coincident with an elevation of the present surface of the earth but more often its center is a valley worn by streams since it was first formed. An anticline must be mapped by the dips of the rocks. Faults are breaks in the earth's crust. Where a fault has resulted in tipping the strata, oil and gas may occur at the top of inclined beds of porous rock where such reservoir rocks are sealed by dense cap rocks the same as in anticlines.

Study has shown that there is a possibility that oil exists in the Quadrant formation of Upper Carboniferous age and in the Colorado shale of Cretaceous age. Some production of petroleum has come from the Quadrant, in Southern Wyoming, and evidences of the presence of oil in the Quadrant has been found in Central Montana. The Colorado shale, or formations correlated with it, produces most of the petroleum and natural gas in Wyoming and Western Canada. Gas has been found in the Colorado at Baker and Glendive, in Montana, and petroleum in Elk Basin, in Carbon County. The gas at Havre is thought to come from the Eagle sandstone.

Oil and gas prospecting in Fergus County will be taken up by describing the companies organized for business in this locality, a few concerns whose office is Lewistown, are included even if they are drilling elsewhere.

The Fergus Oil & Gas Company was organized in 1913, with M. W. Boerema and later Dr. J. H. P. Gauss as president. Several thousand dollars worth of stock was sold, but promotion expenses absorbed this and the company ceased an active existence before doing any prospecting for oil or gas. It was capitalized for $250,000.

The Tanberg Oil Company was organized in 1913 with Lewistown men the chief stockholders. Its operations have been limited to Southern Montana, and to Wyoming fields, where the concern owns a large gas well in Little Buffalo Basin.

A terrace structure at the foot of the Little Belts, west of Garneill, was leased by Judith Gap parties in 1916. The possibility for oil there is in the Quadrant. The structure has never been tested by the drill. A company is drilling south of the Little Belts, on Elk Creek, and expects to test out both the Colorado and Quadrant formations in their well.

The Kansas-Montana Oil Company was organized in 1917 to prospect the Winifred field. Men from Kansas are the chief stockholders. The field has been considered to possess oil and gas possibilities by men from the U. S. Geological Survey and was reported on favorably by Charles N. Gould and other petroleum geologists. The company has leased several thousand acres and is drilling with a standard rig on a faulted dome structure with very steep dips, about three miles northeast of Winifred. The well was 2,200 feet deep in May, 1919. The base of the Colorado lies about 2,500 feet deep on this structure with the Judith River beds exposed at the surface. The Eagle sandstone was struck at 600 feet depth and contained a little gas and showing of oil. A small amount of oil was found in a shallow well dug for water west of Winifred.

The Home Oil Company was organized in 1917, with J. E. Loreman president and manager. The company is capitalized for $500,000 with par value for the stock of 10 cents a share. Fergus County citizens are largely interested in the company, which started drilling with a standard rig at Sour Dough Springs, about 10 miles east of Winifred, in August,

1918, and by the end of the year had reached a depth of nearly 1,000 feet.

The Judith Oil Company was organized in 1917 with Lewistown men the chief stockholders. The capital was $100,000. Fred Warren was president. The company controls over 20,000 acres of leases and drilled a well in 1917 and 1918 nearly 700 feet about a mile from the railroad siding of Piper, on a dome on the McDonald Creek Divide. Production was looked for in the Quadrant, which was penetrated by the drill for almost its entire thickness. Small amounts of gas and a trace of oil were found. Three porous sands were passed through, but each contained water under a great head which made such a great flow of pure artesian water that drilling was somewhat hampered.

The Grass Range Oil Company was organized late in 1916 by Lewistown and Grass Range men and leased 20,000 acres on a big dome at Button Butte, about 10 miles southwest of Grass Range. The company's holdings were reported upon favorably in 1917 by E. A. Ritter, a geologist of Denver. The Jurassic formation is exposed at the surface and the possibility for oil lies in the Quadrant formation. The company sold some stock and tried to interest producing oil companies in testing out the big dome but was unsuccessful. It did not start drilling operations on its own account.

In 1917 a small flow of gas was struck at 165 feet in a well bored for water on the Dengle Bros.' ranch, north of Grass Range. John A. Coleman of Lewistown and others soon organized the Ford Creek Oil Company, with a capital of $500,000, and leased 11,000 acres of ground. Drilling was done with a portable rig in 1917 and 1918, and continued to a depth of about 650 feet. Operations were suspended in the summer of 1918. In order to test out the Colorado at this point it will be necessary to drill to a depth of 1,200-1,500 feet. The formation is perfectly flat here and if oil is present it would probably be in thin lenses of sandstone at the base of the Colorado.

In 1918 the North Basin Oil & Gas Company was organized by residents of the Winifred district with a capitalization of $100,000. Some leases were secured.

The Judith Basin Oil Company was organized in 1918 by Billings and Moore men with the intention of prospecting for oil near Moore.

The Sapphire Oil & Gas Company was incorporated by Lewistown men in 1918 with a capital of $75,000, which was increased to $100,000 in 1919. The company own 3,000 acres of leases near Chanute, Kansas, and by the end of 1918 had 23 producing wells. The Lewistown Oil Company, capitalized for $500,000, was organized in 1919, and owns considerable good ground in Southeastern Kansas, with several producing wells.

The structure of Southeastern Fergus County is favorable in many places for oil and gas accumulation. It must be remembered that the presence or obsence of oil in commercial quantities cannot be told in advance of drilling operations. Southeastern Fergus County is a geanticline or anticlinorium, that is a very large upfold on which are minor anticlines and domes. One limb of this gigantic upfold runs from Black Butte across Box Elder Creek southeast to the Musselshell, which it crosses near Mosby. The strata often dips north very steeply from this limb. The southern limb runs from the Snowy Mountains through Northern Musselshell County into Northeastern Rosebud and Southwestern Garfield County, where it joins the northern limb. An immense dome with slight

dips, farther east, called the Porcupine dome, may be regarded as an extension of this immense anticline, which measures over 50 miles from north to south and 100 miles from east to west. There are many small domes on McDonald Creek Divide which may be regarded as the western limits of the geanticline. Superimposed on this geanticline are at least three long anticlines or series of connected domes. The most southerly runs from the Little Snowies on a curving line through Devil's Basin, in Musselshell County, towards the Bend of the Musselshell. A Roundup company has drilled a well in Devil's Basin and leased a big acreage on this fold. The middle anticline is really a series of domes, of which Button Butte, on Elk Creek, is the most westerly. On Yellow Water Creek, southwest of Winnett, is a large dome on which H. J. Knowles of San Francisco has leased 4,000 acres. This axis of this fold runs a short distance north of Flatwillow for many miles and follows it down toward the Musselshell. The most northerly anticline starts near the junction of Ford Creek and Box Elder and runs about east toward the Musselshell. Several domes have been worked out on it. One of these has been leased by a California company called the Big Six, and other sections by Wright and associates, who are drilling for oil south of the Little Belts. A small flow of gas was encountered ina well drilled for water in a saddle between two of these slightly dipping domes. The Musselshell Valley Oil company was organized in the spring of 1919 and obtained leases northeast of Winnett. From a geological standpoint it seems probable that prospecting for oil on some of the domes in the Winnett section by those who can afford the risk is justified. Oil and gas, if present, will be found near the base of the Colorado shale, which lies 1,500-3,000 feet below the surface on the minor anticlines.

CHAPTER VII.

Non-Metallic Minerals Other Than Fuels.

Sapphire, the gem form of corundum, occurs as flat rhombohedral disseminated crystals in a dike of dark colored igneous rock at Yogo, in the foothills of the Little Belt Mountains. The surrounding rock is carboniferous limestone. The sapphire bearing dike is six miles long, 12 to 20 feet wide, and of unknown depth. Most of the sapphires found in the world come from Yogo, except those recovered from placers.

Sapphires were discovered in the nineties in placers mined for gold. There was not sufficient gold to make its recovery profitable, but the sapphires were traced to their source in 1894. Many claims were located along the dike and the weathered rock was mined in open cuts and the sapphires washed out by hand methods. Later the dike was owned by two companies—the New Sapphire Mining Syndicate, Limited, of London and the American mine. The London company purchased the American mine in 1914 and now controls the entire output of sapphires.

The sapphire bearing rock is now mined by underground methods, and the freshly mined rock is dumped on wooden floors, where it is subjected to weathering until considerably decayed. Then the dirt is washed through sluices and the sapphires being heavier than the matrix material sink to the bottom and are collected from the riffles. This process is repeated on several floors each below the other until probably 95 per cent of the sapphires are recovered. The sapphires collected from the riffles are mixed with pyrite and various other heavy minerals. At the English mine this material was concentrated in a jig, at the American mine a magnetic separator was used. Few sapphires are cut and polished in the United States. Most of them are exported to London, Antwerp and Amsterdam, to be prepared for market there. They are then reimported into America and we have to pay 15 per cent import duties on them as well as paying Europe for their manufacture. Small and imperfect sapphires are used for watch jewels, meter bearings, phonograph points, etc.

The annual value of sapphires mined at Yogo before the war was about $250,000. The total product is probably worth $1,500,000. The war has caused an almost total suspension of mining at Yogo for the last four years. The sapphires produced from Yogo exceeded the value of all other gems mined in the entire rest of the United States.

Th sapphires were formed in the igneous dike by crystallization from the molten mass. The corundum probably was derived by differentiations of the original material but might have resulted from the incorporation of Cambrian shales into the molten rock as it broke and fused its way towards the surface. Curiously enough similar appearing dikes nearby are barren of sapphires.

A considerable quantity of gem topaz has been produced from the West Kendall mine, in the North Moccasin Mountains. Some has been cut into clear, fine appearing precious stones. The output has been worth many hundred of dollars and could be increased. Many "sapphires" picked up in the bench gravels of the Judith Basin are nothing but quartz, though some make pretty settings when cut. Garnet occurs in the Judiths and Belts, but not of gem quality.

Gypsum occurs in Fergus County as diamond shaped crystals, scattered through black shale, of Cretaceous age, in the badlands, and thick pure beds in the Ellis formation of Jurrasic age. Gypsum also occurs in

the Quadrant of Alaska Bench. The beds seem to have been formed by evaporation of sea water in lagoons and small bodies of water. As the water evaporated it would become supersaturated with gypsum and the mineral would be precipitated. Purge gypsum beds, 10-30 feet thick, occur at Hanover, on East Fork of Spring Creek, south of Forest Grove, on Alaska Bench, near Tyler on Flatwillow Creek, etc. No workable beds of gypsum occur around the Judiths, North Moccasins or eastern slopes of the Belts. Gypsum contains water of crystallization. When heated this water is expelled and plaster of paris formed. Wall plaster is made by mixing hair with the dehydrated gypsum. At Hanover the gypsum is mined by underground tunnels and stopes like coal, three feet of gypsum being left to make a safe roof. The gypsum is crushed and powdered, then put in a big iron kettle and calcined; that is, heated to several hundred degrees, in order to drive off the water of crystallization. The Hanover gypsum plant is operated by the Three Forks Company and can produce 200 tons of wall plaster each day. It started producing in 1916. it was first operated by a company of Lewistown men and was sold to the Three Forks Company late in 1916.

The U. S. Gypsum Company has developed a great deposit of gypsum near Heath, 10 miles southeast of Lewistown. This is known as the Casofour Plant. It is developed by two inclines several hundred feet lony connected by a drift. An immense amount of gypsum is in sight and mining can be cheaply done. The war delayed completion of the plant but a large mill will be built as soon as peace comes.

There are millions of tons of gypsum in Fergus County. Only those deposits then which are conveniently located to railroads will pay to exploit under present circumstances. The same is true regarding limestone and clay.

Fergus County is well supplied with most construction materials which include limestone, sandstone, granite, marble, clay, gravel and gypsum.

Pure limestone outcrops in inexhaustible amounts in the Belts, Snowies, Judiths and Moccasins. Formerly it was burnt to lime in small kilns for local use but after the completion of a railroad into the Basin it proved more convenient and less expensive to ship lime in from more modern plants. It seems probable that a modern lime plant should succeed financially in this region. Crushed limestone makes a good mixture for concreate and some is crushed for that purpose at Hanover. Limestone is not used for building stone in Fergus County and does not seem well suited for it. A bed of limestone has been changed to marble on the slopes of Black Butte by an intrusion of igneous rock, but it is not believed that the occurance is of economic importance. The chief use of limestone is to make portland cement at Hanover.

The Hanover plant of the Three Forks Portland Cement Company is one of two plants in Montana owned by this concern and was finished in the spring of 1918. About 200 men are employed and the output of the plant is 1,000 barrels of cement a day. The limestone is quarried near the top of the South Moccasin Mountains and reduced to a two-inch size in a large electrically operated crusher. The coarsely crushed rock is carried by an aerial tramway 14,000 feet long to the cement plant. There it is further crushed by a rotary crusher, mixed with shale, in proper proportion as shown by analysis, and ground in tube mills. The material is mixed with water to avoid dust and the slurry thus formed is conveyed

to the top of a large rotary kiln. The kiln is fired with powdered coal and the slurry is subject to a temperature of 3,500 degrees, which burns it to a clinker. This is reduced to a very fine powder in tube mills and forms portland cement. A little gypsum is added to cement as a retarder to prevent its setting too rapidly. The Hanover plant, including the townsite, represents an investment of over $1,000,000.

Inexhaustible deposits of clay are found in Fergus County. Clay is mined with a steam shovel at Hanover for use in making cement. The clay bed is directly back of the plant and overlies the gypsum deposit.

At Lewistown, Kootenai shales are mined for use for making brick. The plant makes 4,000,000 brick a year and makes building brick, tile and paving brick of exceptionable quality. The shale is crushed and mixed with water and made into brick and tile by forcing through dies and cutting to proper size. It is then dried for a week in a drying kiln and burnt to the finished product of coal fired kilns. There are six kilns in use. Many buildings in Lewistown are of local brick and the product is shipped extensively to surrounding towns and counties. The total value of brick produced by the Lewistown plant to the end of 1918 amounts to a total of $172,372, besides $18,500 worth of tile. The plant represents an investment of $100,000 and was started in 1911.

Sand for cement and plaster work is produced by two plants in South Lewistown, which crush the sandstone to fine sand. They annually produce several hundred yards of sand, worth $3 per yard. The Lewistown Concrete Supply Company operates a plant on Boyd Creek, in Lewistown, where bench gravels are screened and washed to furnish stone and coarse sand for cement walks, etc. A stone crushing plant is frequently operated to provide crushed stone for bithulithic pavements. The railroads have used many thousand carloads of the bench gravels for ballasting roadbeds. The largest gravel pit is located a few miles from Ware; another is near Brooks.

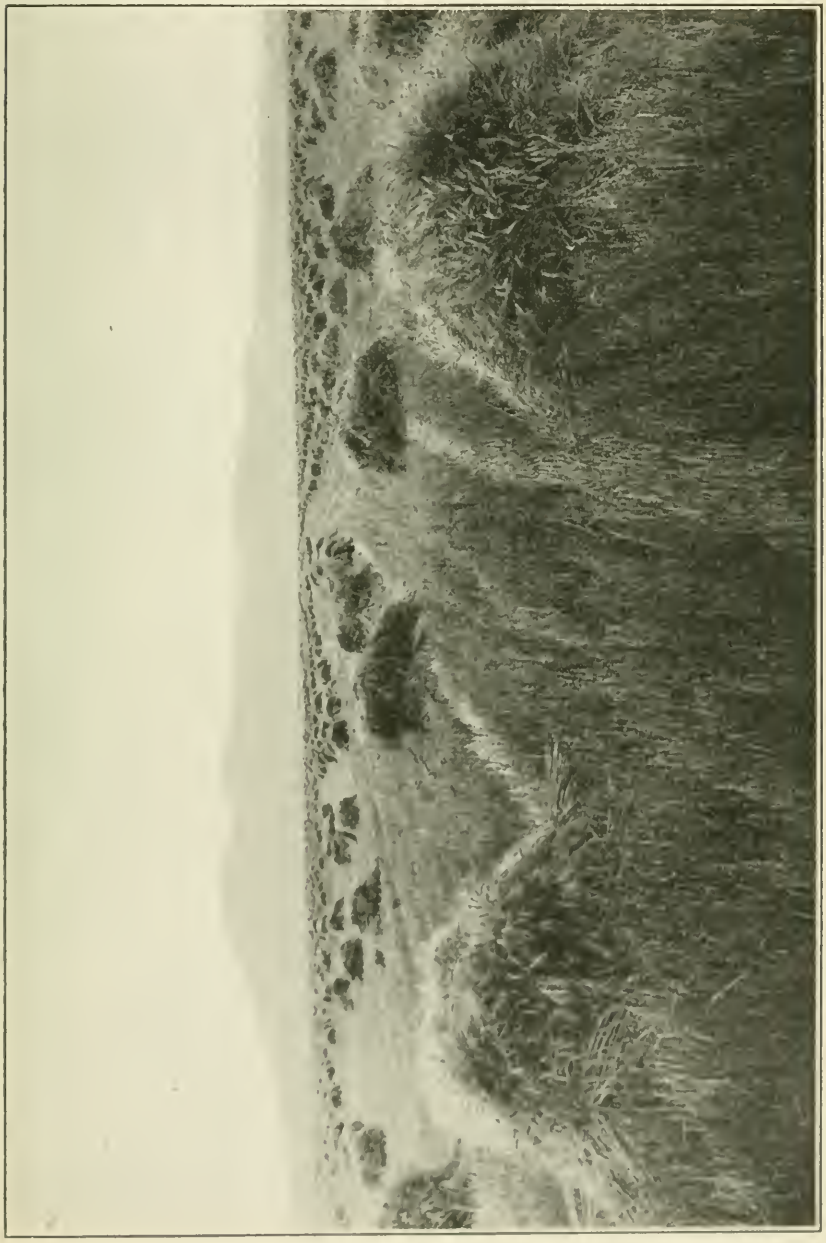
Sandstone, usually that of Kootenai age, has been quite widely quarried for building purpose in Fergus County, especially near Lewistown. It is not an enduring stone and contains iron that rusts and injures its appearance. Many handsome buildings are built from local sandstone, however, for example: In Lewistown, the Bright Hotel, Old High School and Gym, Library, Presbyterian and M. E. Churches, Power's, Lehman's and many other store buildings and residences are built of it. Many buildings in other towns of Fergus County, as well as ranch homes, are built of sandstone. It is easy to quarry sandstone, as it outcrops in bold cliffs.

A little granite has been quarried near Geraldine, in Chouteau County, and a bank building and a few other buildings constructed of it. However, it weathers too easily to make a satisfactory building stone. The porphyry of the Judiths and Moccasins is too deeply decomposed to make a building stone and is never used. Field stone and boulders from the bench gravels are sometimes gathered and used for porch pillars and other decorative purposes, but no homes are built of them.

The high price of potash during the war stimulated search for deposits of this valuable salt. Potash was found in some alkali lakes north of Highwoods, near Montague and Geraldine, and as incrustations and impregnations of alkali in cut banks of shale and on alkali flats. An average of 28 per cent potash was obtained near Pownal. Most places had only a

trace of potash, and in no case did prospecting disclose any deposit that can be worked at a profit. Some igneous rock in the Judiths and at Square Butte contain 8 to 12 per cent potash. If a process for the extraction of potash from igneous rock is ever perfected such rocks will be valuable and can furnish millions of tons of potash.

A specimen of strontianite has been found on Cottonwood Creek, near the Snowies, but no commercial deposit has been located.



WHEAT IN SHOCK.

CHAPTER VIII.

Picturesque Fergus County.

The varied surface features and scenery of Fergus County make it very picturesque. The first things noticed by an observer are the mountain groups, some of which are visible from every part of the county. All Fergus County was once covered by the sea, and as the land was uplighted above the ocean the rocks were folded and mashed together and intruded by great masses of lava resulting in our mountain uplifts. As the mountains were uplifted very slowly the agents of weathering and erosion were steadily at work breaking up and removing the exposed strata, although not as fast as the rocks were uplifted. Rocks nearly one mile in thickness have been thus removed from above the present summit of the mountains. The summits and ridges in the mountains usually result from the greater resistance of certain layers of rock, especially limestone. The frost and other agents of weathering have broken much of the limestone into angular blocks which form steep talus slopes or "slide rock." Frost has sometimes heavy the limestone on the mountains up into piles that appear like the effect of an explosion.

Great masses of lava intruded along bedding planes of the sedimentary rocks and domed up the overlying rocks. These intrusions are called laccoliths and were the cause of the Judith and Moccasin Mountains. The rocks at the top of the dome were probably fractured by the folding they were subjected to, and their positions likewise caused them to be first attacked by the forces of erosion. As a result streams established themselves well up on the slopes of the uplifts, the original top of many of these domes has been removed and a valley exists where once the mountains were highest. Limekiln, Ruby and Alpine Gulches cross laccoliths and the stratified rocks dip away in all directions from the heart of the gulches. Smaller domes doubtless resulting from laccoliths occur at Black Butte, Hanover and on McDonald Creek Divide. The igneous rock usually intruded the Cambrian shales but on the east end of the Judiths the Cretaceous formations were intruded. The dips of the rocks in the Big Snowy Mountains are shorter and steeper on the south, while in the east end of the Little Belts the strata dips steeper on the north. Both the Big Snowy and Eastern Little Belt Mountains result from articli in the east end of the Little Belts the strata dips steeper on the north. Both the Big Snowy and Eastern Little Belt Mountains result from anticlines (upfolds of the rock.) The country east of the Snowies contains a number of faults. An immense anticline (geanticline) occupies Southeastern Fergus County and contains several minor domes, synclines and anticlines. The north flank of the geanticline starts near the Judiths and the rocks dip northward very steeply in places, giving rise to a prominent hogback ridge east of Black Butte. The south flank is in Northern Musselshell County. The two limbs of the anticline extend across the Musselshell and come together in Southwestern Garfield and Northwestern Rosebud Counties.

Wherever rocks are inclined the removal of soft rocks etches the hard layers into relief and forms hogback ridges, which are steep or gentle, depending on the angular dip of the strata. Such hogbacks and sloping benches (i. e., Alaska Bench) nearly surround the Snowy, Judith and Moccasin Mountains. The slope towards the mountains is always steep, as the soft rock under the hard surface layer is removed by erosion except

where protected by the hard. Alaska Bench is being eaten back by the removal of the soft rock which undermines the top hard layer and causes it to fall and slip down hill. Landslides are fresuent on these steep slopes during thaws and heavy rains. Faults or breaks in the rocks occur around the South Moccasins, at Kelly Hill on the Gilt Edge road, near Tyler, near Heath and Castle Butte, on Alaska Bench, the Little Snowy Mountains and at intervals through a great portion of Northern Fergus County from the Judith River, near Fullerton, east for 50 miles. Beds of sandstone have been etched into relief on the faults in the northern part of the county and are often covered with scrub pine trees. When flat laying rocks have been extensively eroded, hard layers of rock have often protected softer rock underneath fro merosion and buttes, such as Dovetail Butte, Chain Butte and those along the lower Judith River have resulted.

Where bluffs and ledges of sandstone are exposed to the wind they are often eroded and etched into all sorts of curious shapes by the sand and dust blown by the wind.

Running water has been the most important agent of erosion in Fergus County and the mountain streams have all slowly carved the great valleys in which they occur. The material eroded from the mountain canyons was in part carried to the ocean and in part deposited along the streams where their velocity decreased. The streams formerly flowed at higher levels and the gravel covering the benches of the Judith Basin was brought from the mountains and left on the benches by running water.

Rivers erode narrow valleys until they lower these to base level, then begin to widen the valleys by undercutting their banks on the outside of the bends and depositing sediment in the still water on the inside of the bends. The result is that a flat or flood plain develops along a stream. If the base level is lowered the stream renews its down cutting and the old flood plain is left above the stream and is called a terrace. Four beautiful terraces exist along the Judith River and are well illustrated at Deerfield. Spring Creek, at Lewistown, plainly shows three stream levels. Each terrace was developed when the stream flowd for a long time at that level. The high benches in the Basin that slope gently from the mountains toward the main drainage lines were developed by widely meandering streams, some of which were probably not in the same locations as the present day streames. From the great extent of these benches, and the fact that some of them extend across the beveled edges of hard and soft rock strata alike, it is thought certain that parts of Fergus County were once reduced nearly to base level. At present nearly all the streams are actively cutting down their beds. A hard bed of rock sometimes causes a temporary base level on a stream This happened at Hanover, on Spring Creek, where the stream flows through a narrow valley cut in sandstone. From Hanover to beyond Lewistown the stream flows through a broad flat valley that was developed at this temporary base level. Between the high level benches and the river flats, the "badlands" or "breaks" are often developed. These occur especially along the Missouri, Musselshell, Judith Rivers and their chief tributaries in Northern and Eastern Fergus County. Badlands develop in soft easily eroded rocks

such as shales interbedded with more resistant sandstone beds, and their formation is helped by steep slopes and torrentials rains.

Dikes occur near the Highwood Mountains and south of the Missouri. They consist of lava that entered cracks in the rocks below the surface and hardened there, and are now exposed by erosion. They are usually only a few feet thick but are harder than the rocks around them and stand several feet above the general level of the country and often can be traced for several miles. Northwest of Grass Range a dike of vertical sandstone a few feet thick extends for about a mile across flat lying shales. It was probably formed by qnicksands being forced into a fissure opened by an earthquake or similar disturbance when the sediments were soft, and the quicksands later solidified.

Many caves, sinks, arches and natural bridges occur in the limestone of the mountains of Fergus County. Water seeped along joints, cracks, and bedding planes of the limestone and when it contained carbon dioxide would dissolve out the limestone, making a cave. Cavities on the face of a cliff were often enlarged by weathering and erosion until only a portion of the rack was left to form an arch, natural bridge or pinnacle. Rock pinnacles and needles have also been formd by erosion and weathering in sandstone. Sinks are very common on the plateau like summit of the Snowy Mountains. Some have been formed by the collapse of the roof of a cavern but more have resulted from the constant enlargement of a fissure by solution and erosion by water. Crystal Lake, a beautiful little body of water on the West Fork of Rock Creek Canyon, in the heart of the Snowies, is probably in part formed by the solution of the limestone strata on which it rests. Its only outlet is underground, and it helps feed the large springs and seeps that are the source of Rock Creek. Many of the streams of the mountains flow underground, except in time of flood, while passing over the outcrops of the thick Carboniferous limestone.

There are many interesting caves in Fergus County. One on top of the South Moccasin Mountains, that had no visible entrance, was discovered while blasting for the crushing plant for the cement rock quarry. It has one large room lined with large crystals of calcite. Several smaller passages open off from this room and some contain small stalactites and columns. The cave can be followed back for about 300 feet. There is a deposit of yellow ochre on the floor left as a residue when the limestone was dissolved. Scores of caves are found in the Big Snowy Mountains. A large cave occurs on Cottonwood Canyon and another on the narrow ridge between Cottonwood Canyon and Careless Creek Canyon. A cave in Horsethief Canyon is said to have once been occupied by counterfeiters. Another cave a few hundred yards above the mouth of Big Dry Canyon contains a trickle of water from the roof to an opening in the floor. Although the cave is only 12-20 inches high in this place deer signs indicate that the animals visit the place for water which in summer is scarce about there, so they must crawl back on their bellies to obtain it. There are no living springs in the limestone forming the top of the Big Snowy Mountains in a dry summer. Herds of sheep pastured there secure moisture from the heavy dews. The sheepherders and forest servic guards obtain water from melting ice mined in ice caves.

There are many caves in Fergus County in which ice exists the entire year and continues to form much of the summer. Several such occur on top of the Snowy Mountains, west of Half Moon Pass. Some of the most

interesting can be visited by following the rangers' trail from Crystal Lake along the telephone line to the tripods that support the wire across the treeless summit. To the west, several hundred yards, ice caves occur above the brink of Rock Creek Canyon. The largest cave is about 100 feet below the edge of the cliffs at the head of Porcupine Creek Canyon. The entrance is of moderate width, and slopes downward for 50 feet, where a good-sized room is entered. The floor is covered with ice and usually two thick columns of ice extend from the ceiling to the floor.

An interesting ice cave exists in the Judith Mountains. It is best visited by stopping a few hundred feet from the foot of the steep hill that occurs on the Gilt Edge stage road and following the trail up the ravine onto the ridge. The cave occurs on the northwest side of the mountain among some thick scrub pine and the entrance cannot be seen any great distance away. A path leads down over broken rock into the first chamber, that rarely contains ice. Another short descent brings the visitor to the second chamber. Here the floor is covered with ice and icicles and columns of ice are often seen in the spring, early summer and fall. The ice, in part, has frozen the rocks of a talus slope together and slopes from the rocks to the floor. This ice results chiefly from the freezing of snow water that seeps down through the rock. Frost usually heavily covers the walls and roof of the cave. The thickness of the ice on the floor of the cave is unknown but probably is several feet where deepest.

In the travertine of the "Park," on the south end of the North Moccasins and on McDanold Creek Divide there are a large number of long, narrow fissures, some of which descend many feet below the surface of the ground. Ice lasts during the summer in several of these fissure caves. They are easy to reach and interesting to visit.

Ice caves occur in the Little Belt Mountains, near the Twin Sisters.

The ice in the caves originates in different ways. A considerable part seeps in on the floor from melting snow and early spring rains and freezes there. A little snow is blown in and is consolidated to ice but the ice would not last all summer from this source. There are many crevices and cracks in the limestone leading off from the caves. During the winter cold air, often chilled many degrees below zero, would enter the fractured rock and cool it considerably below freezing. Frost freely condenses on such rock surfaces and sometimes is nearly an inch thick. Any air that emerges from the crevices of the rock is chilled below the freezing point and freezes the water that drips and seeps into the cave. The ice remains dry and continues to form during the spring and early summer and fall. During the winter there is no water enteing the cave to freeze. During the last of the summer the ice may slowly melt, but there is too much to entirely disappear during the few weeks after the supply of "cold," stored in the rocks, is exhausted. As a result, the ice lasts the entire year. An ice cave is an interesting place to visit, and is esspecially pleasant for picnic parties in the summer.

There are several large springs in the county. The Big Spring, five miles above Lewistown, is best known, it suffices for the municipal water supply and furnishes most of the water in Big Spring Creek. The water flows underground through porous sandstone from the Snowy Mountains to the spring. The Warm Spring between the North and South Moccasin Mountains furnishes all the flow of Warm Spring Creek which is enough

to run a small power plant and irrigate a large acreage. Vast hot springs formerly existed around the Judith and Moccasin Mountains, that deposited thick beds of travertine covering many square miles of land.

There are only a few lakes in Fergus County, Crystal Lake, in the Big Snowies, is most picturesque. It is a shallow body of water, half a mile long, but is surrounded by high forest covered mountains and is a beautiful camping site. War Horse, Wild Horse and Bear Lakes are north of Grass Range. The lakes occur in a treeless country and their basins were probably formed in part by deflation by the wind. Around the steep face of Alaska Bench are several landslide lakes where water collects in depressions above a landslide block. Such landslide lakes can be seen at the base of other hogback ridges and benches that surround the mountain groups. Beaver frequently dam up the clear streams and while good farm land is sometimes injured, the animals add greatly in making the streams more picturesque.

The mountain and foothill streams are usually well filled with trout and often cascade swiftly on their course between banks shielded to the water's edge with thickets and trees. Cottonwood, Rock Creek, East Fork, Swimming Woman, North Fork of Flatwillow are beautiful streams to follow up the deep wide canyons they have carved in the Snowy Mountains. Towards their head the steepness of the slopes increase and cascades and waterfalls are higher. In most of the canyons hard layers of rock in the bed of the stream cause waterfalls in some places 10 to 20 feet high. The hard rock layers often have a gentle dip and result in the floor of the valley resembling a series of gigantic steps. The canyons in the mountains are being cut headwards and often have resulted in cutting down the main range of the mountains to a knife edge ridge, as between Careless and Cottonwood Canyons, in the Big Snowies. This forms the prominent notch in the mountains visible from the Basin and is often mistaken for Half Moon Pass. Half Moon Pass was originally the summit of the Big Snowies and has been formed by the headway erosion of the North Fork of Flatwillow and Swimming Woman Creeks.

The steep square cut limestone cliffs, the tumbling torrents of water, the wonderful views across Montana from Canada and Yellowstone Park that one can enjoy from the summits of the mountains, the clear sky, the swaying pines and the fleeting birds and timid deer, make a camping trip in the mountains something distinctly worth while and decidedly picturesque.

CHAPTER IX.

Climate and Ground Water.

Government precipitation records prove that the rainfall of the Judith Basin is 16½ to 20 inches annually, about one-fourth more than the country north, east, south and west. The greater rainfall makes failure of crops from lack of rains nearly unknown, and one summer fallow in three or four years appears to be sufficient to insure good crops. The precipitation in the foothills and mountains is more than in the Basin. In Northern and Eastern Fergus the rainfall is not as great as near Lewistown, and summer fallowing once in two or three years is necessary to insure a good yield of grain. Experience has abundantly proved the value of the clean summer fallow in conserving moisture for the following season, except on very porous gravel underlain at two or three feet depth by a hardpan of gravel cement.

Weather records have been kept at Utica since 1893 and at Lewistown since 1895. These show that at Lewistown 9.12 inches of rainfall in the three growing months of May, June and July, or 45 per cent of the moisture falls in 25 per cent of the time. At Utica, 8.31 inches or 50 per cent of the total fell on the average in the same months. This very favorable distribution of rainfall is of great help to agriculture. The May and June rains are of most importance for the winter wheat and the June and July rains for the spring grain. Six Junes at Utica and six at Lewistown had less than two inches of rain instead of the average of 3.5 inches. Dry Junes either at Utica or Lewistown occurred in seven years out of twenty-five and came in pairs in 1899-1900, 1903-1904, 1917-1918. There have never been three dry Junes in succession. Less than one inch of rain fell in June at Lewistown in 1912, but May and July had above the average rainfall so crops suffered little. The same was true of much of the Basin in 1918. In only May, 1897, did the May rains fail in Lewistown and that was followed by a rainy June and July. May is not as rainy at Utica and the May rains were less than two inches in 10 years and less than 1.6 inches in four years. July rains were less than one inch at Utica in seven years out of 25. At Lewistown three out of 23 years had a light July rainfall. In only 1900 and 1917 was the rainfall at these stations deficient during both June and July. Little grain was planted in 1900 but in 1917 crops suffered generally. In 1918 partial failure resulted from lack of rains in June and July in Northern Fergus County. The occasional dry years merely prove that on the average no section of Montana is favored climatically so well as Fergus County.

The winters in Lewistown are dry, less than an inch of rainfall occurs in each of the months of November, December, January, February and March. The winters are generally mild, being tempered by the chinook winds, as in 14-15 and 1917-18. February, 1916, was the coldest month on record, as for 25 days in the month the thermometers did not rise above zero, with 4.1 degrees Fahrenheit, the lowest temperature. The coldest recorded temperature in Lewistown is 42 degrees Fahrenheit, but other parts of the country have reported occasional unofficial records below this. The hottest months are July and August. A temperature of 99 degree Fahrenheit was recorded in July, 1914, which was the hottest, dryest month since 1908. Spring wheat was damaged one-half by this hot wave, but the winter wheat was exceptionally good. The autumn

weather is usually open with favorable weather condiitons for seeding and plowing. September has more rain than either August or October. 1895 is the dryest year on record at Utica. Two months were without rain and the total precipitation was less than 10 inches. The dryest year on record in Lewistown was 1904, when 13½ inches of rain fell. The wettest year was 1909 when nearly 25 inches of rainfall occurred at Lewistown, and over 24 inches at Utica. 1915 had perhaps the most generally favorable of conditions in recent years. June 1909 had the most rainfall, in any one month in Fergus County, when it amounted to 6.66 inches.

Hailstorms sometimes damage crops considerably in Fergus County. Hail is usually very local, and such storms were most frequent in 1912, 1915 and 1918. Hail most frequently occurs in the foothills, but probably no section of the county is entirely free from dangers of hail, although usually severe hail is a rare occurrence.

The growing seasons for crops is not as long as in more southern states, but due to the more northerly locations the sun shines for more hours a day and crops mature more rapidly.

There is no evidence that the climate of Fergus County has changed since records have been kept. Different years, however, may vary considerably from the average. There seem to be a series of years that have above the average rainfall followed by a series that have less than the average. These series of wet and dry years probably occur in rather definite cycles, but records have been kept for too short a time in Montana for the author to attempt to make any generalizations regarding this matter. After a study of local records up to the end of 1918, the writer believes that at least two of the next three years will be very favorable for grain crops, and that at least one and possibly two of the winters during the same time will be severe.

Only a small part of rainfall enters the soil, probably more of snow water enters the ground than of rain. Part of the rainfall runs off, part evaporates and a small part disappears by percolations. Since the chief cause of variations in yields of crops is variations in rainfall, the farmer should seek to conserve it and plant drought resistant crops as hard winter wheats. The time rain falls is very favorable to crops in Fergus County. Torrential rains and hailstorms may be very destructive to crops, but fortunately our rains are usually gentle.

The precipitation records secured at Lewistown, Moccasin Experiment Station and Utica are as follows. Records were not kept at Lewistown in 1917 and in two other months, so the records at Moccasin have been used for those periods.

LEWISTOWN—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1896	1.65	1.50	1.60	3.90	2.63	2.33	2.06	0.39	2.86	0.38	2.43	T	21.73
1897	0.92	1.84	1.15	1.10	0.84	3.54	3.38	...	...	2.55	3.97	1.10	....
1898	0.55	0.80	3.16	1.15	4.41	5.11	...	...	...	...	...	.....	.....
1899	...	0.40	1.80	1.58	...	...	...	...	...	....	.....	.....	.....
1900	...	...	...	...	...	1.50	0.55	4.20	0.80	1.00	0.32	0.90.	.....
1901	T	0.02	1.10	1.10	4.45	3.50	2.00	0.02	1.20	0.50	0.05	2.25	16.19
1902	0.55	1.30	.45	2.00	4.00	6.00	3.60	0.70	0.40	T	0.65	1.30	20.95
1903	0.47	1.30	0.55	2.90	4.70	1.75	5.60	0.75	2.42	0.25	0.70	0.70	22.09
1904	0.92	1.15	1.90	1.65	2.10	0.50	3.45	0.60	0.20	T	0.05	1.00	13.52
1905	0.40	1.00	0.55	1.10	2.15	4.50	1.20	0.80	1.20	0.75	0.70	0.00	14.35
1906	0.50	0.60	0.80	0.10	3.78	5.47	2.00	0.60	2.10	0.95	0.89	1.31	19.10
1907	1.88	0.47	0.92	0.45	2.25	3.90	2.14	3.24	0.75	0.26	T	0.25	16.51
1908	0.49	1.55	2.10	0.34	4.09	4.00	0.04	1.04	2.00	5.80	0.25	0.40	22.10
1909	1.25	0.10	1.27	1.19	2.50	4.86	4.20	2.73	4.24	0.49	0.91	1.21	24.94
1910	1.40	0.91	0.25	1.73	2.26	2.28	2.20	0.81	3.03	1.05	0.98	0.50	17.40
1911	1.54	0.46	0.67	1.64	5.18	3.12	1.75	4.15	1.81	1.96	1.32	0.57	24.17
1912	1.18	0.05	0.56	2.23	4.27	0.80	4.12	1.16	1.93	2.03	0.04	0.41	18.78
1913	1.31	0.31	0.27	0.69	2.26	6.33	1.66	1.12	1.88	1.82	0.69	0.36	18.70
1914	0.32	0.04	1.26	0.17	3.20	5.57	.53	1.19	1.92	1.33	0.47	0.22	16.22
1915	0.65	0.02	1.61	1.31	3.70	5.47	3.93	1.78	1.66	1.11	0.85	0.80	22.89
1916	0.80	0.51	0.91	1.80	2.43	4.15	2.39	0.70	1.76	1.34	0.78	1.47	19.04
1917	1.87	1.30	0.85	1.18	2.79	1.81	0.96	0.75	2.91	0.62	0.09	2.56	17.69
1918	2.34	0.87	0.38	0.18	3.32	1.68	2.08	3.14	1.28	1.76	0.52	0.16	17.71
T. Mean	0.99	0.75	1.13	1.34	3.21	3.55	2.37	1.49	1.86	1.28	0.81	0.83	19.58

UTICA—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1894	...	...	...	...	1.68	4.46	0.30	0.86	1.32	1.34	0.48	0.44	.....
1895	...	0.26	0.15	0.75	0.39	3.76	1.31	0.00	0.45	0.00	0.80	0.52	....
1896	0.80	0.30	1.02	0.20	3.06	2.35	3.42	1.93	2.38	0.55	4.67	0.00	20.68
1897	0.30	0.46	0.71	0.87	1.33	3.98	1.74	0.30	0.15	2.36	1.68	0.80	14.68
1898	0.70	0.27	1.91	1.12	5.87	5.80	3.16	0.67	0.47	1.25	1.14	0.43	22.79
1899	1.69	0.38	0.92	2.29	3.33	1.22	2.57	1.31	0.28	1.15	0.11	0.88	16.13
1900	0.45	0.35	0.21	2.85	1.04	0.44	0.70	2.20	0.82	0.86	0.29	0.21	10.42
1901	0.40	0.20	0.57	1.65	3.82	3.97	1.97	0.90	2.42	1.39	T	3.22	20.51
1902	0.14	0.24	0.45	1.12	1.41	3.28	1.84	0.67	0.32	0.18	2.04	0.25	11.94
1903	0.50	0.24	1.11	2.29	1.82	2.81	2.57	0.81	2.42	0.05	0.44	0.65	15.71
1904	0.18	0.22	0.79	1.14	1.94	1.73	3.25	0.42	0.12	0.54	0.50	0.24	11.07
1905	0.19	0.16	0.62	0.75	1.97	2.82	3.19	0.27	0.83	0.39	0.50	T	11.69
1906	0.55	0.63	0.43	0.16	2.61	2.66	0.93	2.00	0.99	0.70	0.42	0.68	12.76
1907	1.34	0.08	0.61	0.43	3.21	6.75	3.51	1.47	0.73	0.20	T	T	18.33
1908	0.55	0.49	0.98	0.61	7.31	2.45	0.20	1.18	1.41	6.27	T	0.22	21.67
1909	0.90	0.08	1.22	0.95	1.84	6.66	4.97	1.28	4.27	0.49	0.30	1.20	24.16
1910	1.20	1.18	0.60	1.32	3.46	1.99	1.23	0.67	2.47	1.43	0.73	0.31	15.99
1911	0.62	0.51	0.81	0.92	4.05	5.17	1.12	5.37	1.02	1.19	0.62	0.20	21.60
1912	0.50	0.33	1.15	1.27	3.94	2.16	1.27	1.67	1.64	2.28	0.15	0.23	16.59
1913	1.45	0.35	0.38	2.00	2.78	4.64	2.14	0.59	1.13	2.59	1.60	0.26	19.91
1914	0.31	0.35	0.92	0.66	3.70	4.85	0.73	0.70	0.96	0.90	0.20	0.23	14.51
1915	1.02	T	1.57	1.27	1.67	4.89	5.21	2.25	2.71	0.52	0.39	0.28	21.78
1916	0.58	1.04	0.84	1.13	2.57	3.78	1.64	1.31	1.07	1.08	0.37	1.61	17.02
1917	0.20	0.86	0.69	1.67	3.43	1.65	0.31	0.47	2.21	0.76	T	1.02	13.27
1918	1.06	0.36	0.84	0.71	2.86	1.30	3.98	0.93	2.00	1.10	.52	.16	15.82
T Mean	0.68	0.39	0.79	1.17	2.84	3.42	2.13	1.21	1.38	1.18	0.72	0.56	16.46

MOCCASIN—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1909	.90	.08	1.22	1.03	1.34	5.97	2.54	4.21	4.47	.49	.30	1.21	23.76
1910	.09	.74	.10	1.31	2.40	1.69	1.10	2.02	2.54	1.36	1.26	.48	15.09
1911	.58	.55	.54	1.66	2.98	2.55	.50	6.34	1.37	1.94	1.76	.68	21.45
1912	.88	.09	.81	1.43	3.94	.64	1.92	1.27	1.63	1.68	.14	.06	15.00
1913	.89	.09	.20	.79	2.64	4.77	1.12	.51	1.01	1.63	.93	.38	14.96
1914	.17	1.35	1.12	1.19	2.91	4.64	.64	.65	1.11	.74	.64	.21	15.67
1915	.76	.08	2.69	1.43	2.12	3.97	3.54	.92	2.65	.85	1.01	.66	20.68
1916	0.74	1.22	1.33	1.20	2.25	3.97	2.03	1.29	1.81	1.00	0.64	2.39	19.87
1917	1.87	1.30	0.85	1.18	2.79	1.81	0.96	0.75	2.91	0.62	0.09	2.56	17.69
1918	2.34	0.62	0.55	0.44	2.69	1.55	2.95	1.48	1.25	1.10	0.52	0.16	15.65
T. Mean	0.93	0.58	0.87	1.19	2.82	2.99	1.97	1.44	1.59	1.11	0.57	0.92	16.98

Ground Water.

The depth at which ground water occurs depends on the amount of rainfall, rate of evaporation, character of surface, character of soil, subsoil, and bedrock. There are some parts of Fergus County where it is difficult to obtain sufficient amounts of pure, potable water. This is especially true where the thick black Colorado and Bearpaw shales outcrop. The shale is too dense for water to sink through, with the result that no water can be obtained except when beds of sandstone are struck and even then the water is frequently alkaline and unfit to use.

The bench gravels of the Judith Basin are underlain by clay or shale through which water will not sink and hence pure water can usually be obtained by digging shallow wells. The Kootenai, Jurassic and upper Carboniferous sandstones are usually thoroughly water soaked and wherever these can be reached with the drill a large water supply can be tapped whose quality is usually good. Springs are very common where these sandstones outcrop. The Big Springs, six miles from Lewistown, which supply the city with water, gush from the Jurassic sandstone in a downfold of the rocks, or syncline, that extends from the Snowy Mountains to the springs. Warm Spring, between the North and South Moccasin Mountains, also emerges from Jurassic sandstone. Many of the springs from the Kootenai sand contains small amounts of iron which causes the water to have an iredescence resembling an oil seep.

Many streams of good water wend their way across the plains from all of the mountain groups. Within the mountains the streams usually flow underground in the canyons where they cross the outcrop of the massive Madison limestone except in times of flood. The water reappears in the beds of the streams some distance from the mountains. During the dry season many small streams in the county cease to flow and often water only occurs in pools along their course. This may sometimes be alkaline or polluted by stock and yet be the chief source of water supply for several miles. North of Hilger and Roy and east of Grass Range and Roy water is often quite difficult to obtain, and when struck may contain too much gypsum and alkali for use except for stock. To obtain water for stock it may be necessary to dam up a coulee to retain snow and rain water. The pond can usually be made water tight by the tramping of the mud bottom by the stock but the pond will not hold water if the dam is built on very porous soil or rock. In case the soil is porous the sod above the dam should be left as it makes the pond tighter. If a well is dug below the pond, better water for household use can be secured, as impurities in the water will be filtered out by the soil as the water sinks down to the well. Ice is sometimes gathered and supplies soft drinking water in the summer when it melts, as the alkali in the water is excluded when the ice forms.

No simple laboratory test can determine whether water is safe to use for domestic purposes as the water may affect individuals differently. The same is true regarding irrigation water. Water heavily impregnated with alkali can be used safely on porous soil, while if the same water is applied to a heavy clay or gumbo soil the water cannot drain away and the soil will quickly become so impregnated with alkali that crops will not grow. Heavy clay soils often contain an excess of alkali at a shallow depth and if flooded carelessly with even fresh water the water will dissolve the alkali in the ground and when it rises by capillarity to the surface and

evaporates the alkali will be left and the soil may be severely damaged. Proper drainage will remedy this condition.

Considerable land is irrigated in Fergus County chiefly for hay crops, as alfalfa. In 1907, there were 22,700 acres irrigated in the Judith River section, 8,800 acres getting water directly from the Judith, 4,650 acres from Warm Spring Creek and 2,900 from Big Spring Creek. Flood waters could be stored on many of the tributaries of the Judith in the foothills. There are good power sites available on the Judith River below its junction with Big Spring Creek. In Eastern Fergus County there are considerable areas along Flatwillow and Box Elder Creeks that are irrigated. A large territory north of Winnett will be irrigated from the recently completed ditch of the Winnett Irrigation Co. This gets its water by storing flood waters. The Flatwillow project, south of Winnett, will irrigate 25,000 acres of land ultimately. It will utilize the flood flow of Flatwillow Creek, the direct flow being used already on alfalfa land.

Grain growing in Fergus County is greatly helped by the usually favorable distribution of rain during the growing season. In order to insure the best results, especially in the occasional dry years, it is necessary to practice proper methods of cultivation and croping. When properly carried on these will conserve the fertility of the soil as well as its water content, and it is well known that more fertile the soil the less the amount of water required by growing crops.

Artesian water can be obtained in many parts of the country by drilling wells down to water-soaked sandstone. A vein of water is simply a porous rock filled with water. If the source of the water is at a higher level than the mouth of the well the water will flow over the top of the well. The most favorable places to drill artesian wells are in synclines (down folds of the rocks) and in places where the rocks dip way from the mountains. A good flowing well of soft water has been drilled in the brickyard at Lewistown where there is a small structural basin. A strong flow of water was struck a mile north of Piper in a well drilled for oil. There is a good artesian well at Fullerton, on the Judith River, and several others in other parts of the county. Deep drilling is expensive, but if the Kootenai and Jurassic sandstones can be reached pure soft water will be found. The Kootenai sandstone is probably less than 2,000 feet below the surface at Winnett and an abundant supply of soft water can be obtained by drilling deep enough to reach it. The water in the thin sandstones at the base of the Colorado shale is often rather alkaline.

CHAPTER X.

The Soil of Fergus County and Its Influence on Agriculture.

Soils result from the disintegration and decomposition of rocks modified by organic remains. Soils may be residual or transported. If they are residual their character is determined by that of the bedrock. If they have been transported their source has been from many diverse kinds of rocks and they are more apt to contain all kinds of plant food in an available form.

All good soils should contain nitrogen, potash and phosporus in a soluable form and should be in a good physical condition for the successful growing of crops. Those interested in a complete discussion on soils are referred to any textbook on the subject, as in this chapter we shall consider only the chief types of soils in Fergus County and their influence on agriculture.

Residual soils found here include those formed from sandstone, shale, limestone, porphyry and other igneous rocks, and mixtures of them. Their character thus depends on that of the bedrock

There are no great areas of sandy soil in Fergus County. The sandstone beds are usually relatively thin and the sandy soils are usually mixed with clay. Sandy soils absorb rain water easily but lose it rather quickly by evaporation and are quite susceptible to damage from blowing by the wind. Sandy soils permit ground water to leach out much of the soluble salts valuable for plant food.

Therefore sandy soils are never alkaline and are usually less fertile than less porous soils. However, they are easy to work and can be plowed earlier in the spring than heavy soils. A certain amount of sand is desirable in the soil as it helps to put it in a good physical condition, so that plants can utilize whatever fertilizing elements are present.

Soils formed from the decay of limestone may lack certain elements, especially nitrogen, but if the limestone is impure the soils are among the richest and best that occur. The Jurassic and Quadrant formations contain shaly limestone that makes good soil on which fine grass and hay grows, as on Alaska Bench. The travertine on McDonald Creek Divide and the "Park" plateau, south of the North Moccasins, makes a very fertile soil, but one which is sometimes thin and stony. The early Carboniferous rocks contain much limestone, but outcrop too far up in the mountains for crops to be grown, but often support a splendid growth of grass valuable for pasture, as around Half Moon Pass, in the Snowies. Where the Madison limestone dips steeply the broken rock is washed or blown off and the soil is thin or absent, but if the dips of the rock are gentle, a very rich soil has resulted. Due to the high altitude this limy soil is mainly devoted to grazing land and timothy hay. The soil is black from its high humus content and with the abundant rains in the foothills, makes about the best natural hay and pasture land in the county. Narrow bottom lands near the mountains on the creeks flowing from the Belts and Snowies make unexcelled soil due to the fact that they are largely formed by the erosion of the decayed portion of the mountain limestone. Lime prevents an acid condition of the soil. Limestone usually contains potash and phosphorus which is liberated for plant use by its decay. The bench gravels of the Judith Basin contain a very large proportion of limestone transported there from the mountains by running water. No finer grain lands exist in the world than these limy gravels. Their only defect is that

their nitrogen content is consumed by straight grain growing. Rotation of crops, and the keeping of stock will help maintain their fertility.

The soil formed from shale is a heavy clay, very sticky when wet. It holds water well but does not allow it to soak in rapidly. The black Colorado, Bearpaw and Claggett shales often form extensive gumbo flats. They are covered with sagebrush rather than grass. Usually in Fergus County the presence of sagebrush instead of grass indicates an inferior soil. Gumbo soil is impossible to work when thoroughly wet and does not dry out as soon as sand or loam, so cannot be worked as earily in the spring. Heavy clay and gumbo contain abundant mineral salts, since ground water cannot readily leach them out, but they often lack humus and therefore are not in the best physical condition. Plowing under straw and green manure crops might help put them in better physical condition. There is often an excess of alkali in gumbo soil as the ground water dissolves the alkali and brings it to the surface by capillarity, where it is left when the water evaporates. The white crusts of alkali are chiefly common salt and glauber salt (sodium sulphate). Sodium carbonate reacts with the humus and forms black alkali which is the most harmful form as a small quantity will kill growing plants, and it also puddles the soil. Gypsum added to soil containing black alkali changes it to the relatively harmless sulphate. If heavy soils, especially with tight subsoils, are irrigated great damage is sometimes done as the water dissolves alkali from the ground and concentrates it at the surface where it kills the plants. Thorough drainage and less frequent irrigation benefit such soils. Surface mulching and the planting of alkali resistant crops are also beneficial. As before mentioned, gumbo soils contain plenty of planty food, but are sometimes in such poor physical condition that plants cannot grow well. Excellent crops of grain are frequently raised on gumbo soil but crop production is not considered so certain as on the bench gravel and loam soil. Alfalfa and other hay crops often do well on heavy clay soils.

True loam covers considerable areas in Fergus County. It generally results when the bedrock is impure shale and shale interbedded with thin sandstone and limestone strata. These conditions are true of much of the Jurassic, Quadrant, Kootenai, Eagle and Judith River formations and hence good loam soils usually are formed where they outcrop. Both fine and coarse materials unite to form loan which gives it the advantages possessed by both heavy clay and sandy soils without the disadvantages of either. Loam usualy contains more humus than most other soils.

River deposited silts make up the soils of the flat bottom lands along the chief streams in the county. All kinds of crops are grown on them, especially alfalfa and timothy.

Igneous rocks contain several minerals and their decay usually makes good soil. However, in Fergus County nearly all the the igneous rocks occur in the mountains, and no extensive soil areas that can be used for farming have resulted where such rocks outcrop.

Glaciers have not appreciably affected the soils in any part of Fergus County. Thousands of years ago a glacier come from Canada and crossed the Missouri in Northeastern Fergus County. Only a few hard rounded boulders of rock, entirely different from any bedrock in Montana, remain scattered sparingly over the surface as evidence of the presence of the glacier in the past. Glaciers affected considerably the soils in many parts of Montana but were of no importance here. They never were found in our mountains or in the Judith Basin. In general, the soils of the Judith

Basin contain more potash, phosphates and nitrates than is usual in eastern soils as the rainfall is not enough to leach them out so completely.

There is usually less difference between the sub-soil and surface soil of the arid and semi-arid lands of the west than in regions of heavier rainfall especially as regards the content of nitrogen in the form of humus. The soils of many parts of Fergus County are deeper than the average eastern soil, but much of the soil on the benches in the Basin varies from a few inches to a few feet in depth and is underlain by a limestone gravel that in places is so firmly cemented together with lime as to be impervious to water. The nitrogen content of these bench gravel soils decreases considrably after the first foot in depth. Steady cropping of grain, especially where burning of the straw is practiced, rapidly exhausts the humus in the soil and the crops suffer for lack of nitrogen. The use of a header and combine is desirable as it permits the return of most of the straw to the soil, which is an advantage unless the straw is so heavy that it cannot readily be plowed under the ground. Fresh or coarse organic matter like unrotted manure and long straw loosens the soil and frequently injuries it and the nitrogen content of such materials is not available until humified. Experience shows that summer fallow pays in Fergus County except in the foothills and very porous limestone gravel soils, but a dust mulch on light soil promotes blowing by the wind and is undesirable. In Fergus County the best soil amendments would seem to be barnyard manure, green manure crops, and crops rotations with consequent plowing under of alfalsa and other legumenous crops. It should be mentioned, however, that agriculture has been practiced too short a time in Fergus County to exhaust the plant food in the soil, and at the Moccasin Experiment Station they have yet to learn of a profitable return from the application of barnyard manure or of green manure. Continuous grain growing will ultimately exhaust the fertility of our soils, just as has happened in the Illinois prairies and the Red River Valley. The leguminous plants constitute the cheapest form of renewing the nitrogen content of the soil. Alfalfa probably is the best crop where it can be grown. It does well on any soil except those that are too high and dry or are water soaked. Alfalfa is even quite alkali resisting once it has reached maturity. In Eastern Fergus County corn and field peas do well together as the corn exhausts nitrogen from the soil and the peas return it.

Commercial fertilizers are rarely needed and it is doubtful if it will pay to add it to soil used for grain farming. The keeping of livestock in connection with grain farming and the resultant return to the soil of as much of the valuable fertilizers as possible cannot be too strongly recommended. Intelligent farmers maintain the content of minerals in the soil required for plant growth at a high figure.

CHAPTER XI.

Geographic Influences in Fergus County.

The early history and development of Fergus County has been considerably influenced by the geography and geology of the region.

The early explorers of Montana, De La Verendrye, a French Canadian, and Lewis and Clark kept to the Missouri River Valley, as they used boats for their journey. Cabins were later built at suitable places by trappers, wolfers, and wood cutters who supplied steamboats with fuel. Trading posts were built at the mouth of the Musselshell and Judith Rivers, but trouble with Indians and the broken character of the surrounding "badlands" caused them to be abandoned. When low water prevented steamboats from reaching Fort Benton cargoes were landed at Cow Island and hauled across the Judith Basin to Helena. The long grass of the Judith Basin caused many teamsters to winter their bull teams in Fergus County before the seventies.

By 1880 several hardy pioneer stockmen had driven herds of sheep and cattle in the Basin, and miners had located metal deposits in the mountains, and Fergus County continued to be chiefly devoted to stock-raising and mining for the next 25 years. The stockmen settled where there was living water, i. e. springs or running streams, for their herds. The native grass in the Basin was long and often reached a horse's belly. The usually mild winters obviated the necessity of providing much hay or shelter for the stock. Oats and hay were principally raised on the valley flats and were very often irrigated. General farming was thought practical only in the foothills. There was more than a 100-mile drive to the railroad from most parts of the county, which fact prevented the export of bulky products, such as wheat. The hoofs of sheep and cattle sufficed to carry them to the railroad, and wool was very valuable for its weight; so the expense of hauling it was relatively small. Hence the chief exports were fat beef cattle, sheep, lambs, wool, gold, some horses, and hides. Some of the chief difficulties faced by the stockmen were occasional blizzards, and severe winter that froze and starved their stock to death. Sometimes dry summers caused a shortage of feed and water, but this was less common than in most of Eastern Montana. Stock "rustling" was not a great drawback, as the "rustlers" usually had few chances to repeat their offences. The homes of the stockmen, located beside streams or springs for the sake of the stock, were often situated in a broken country which provided better shelter from storms than the level benches. Land along the streams was early homestead, or secured by desert entries, since hay was usually grown on the bottoms, while the owner controlled the water for his stock. The first land taken up in Eastern and Northern Fergus County was often "badlands," which contained springs, giving the owners virtual control over many sections of free grazing land. Land could be taken up as homesteads, desert claims, tree claims, under timber and stone act, by buying from the State and the Northern Pacific Railway, and by Soldier's Additional and other kinds of scrip. There was so much land that the land laws were often laxly enforced, with the result that many far-sighted men secured thousands of acres at a very nominal cost. The first stores, saloons, stage stations, and trading posts were built at convenient camping sites or close to mines and large stock ranches, where

customers would be easiest to secure, as Utica, Lewistown, Grass Range, Maiden and Tyler.

The old trails were located in the easiest and shortest practical course between towns. Later the distance between towns was often lengthened when roads were shifted to section lines. An old Indian trail through the Basin led through Beaver Creek Gap, this was followed by the stage road south and finally by the railroad, as it was the lowest path across the hills and Beaver and Cottonwood Creeks to Lewistown. After the railroads came, grain growing began to be the great industry of the county and many small towns sprang up at convenient distances along the railroads as grain shipping points and supply centers. Some of the old towns and stage stations were abandoned in favor of a location on the railroad, as Philbrook for Hobson and as old Stanford and Garneill for their present sites. Lewistown had the advantage of an early start and central location. Its citizens were progressive and possessed initiative and hence the city has maintined and even increased its relative importance in the county.

The past geological history of Central Montana has determined the location of gold, coal, limestone and sapphire deposits and half a dozen towns resulted from the location of the mines, as Maiden, Kendall, Gilt Edge, Hanover, Lehigh and Yogo. The decomposition of the rocks supplies the needed fertilizers in the soil and the presence of the mountains helps increase the amount of rainfall. It was thought impossible to raise crops without irrigation in Fergus County in the early days, and this erroneous idea delayed farming operations. The lack of experience in dry land farming and the great distance to the railroads prevented any considerable agricultural development until about 1904 and 1905 when the completion of the Montana Railroad enabled the farmers to ship their wheat. When it was demonstrated that wheat could be grown in the Judith Basin without irrigation thousand of homesteaders came into the county. The Judith Basin cattle ranches were replaced by wheat farms and new towns sprang into existence. The availability of the land for grain growing has caused the Milwaukee to build lines to Great Falls, Winifred, Roy and Winnett, and is the determining factor in the Great Northern extensions east, but the Great Northern will also shorten its main line considerably by this new route. Grain growing was unprofitable until railroad construction provided a market.

Manufacturing could not succeed until then, either. Manufacturing is small and consists of cement, gypsum, brick, flour, butter, etc., all products made from raw materials that are close at hand and for which a local market is available. The railroads have resulted in thousand of homesteads being taken up throughout Fergus County as a market was provided for the agricultural products. The increase in homesteads has gradually eliminated most of the free range and the large stock ranches appear to be nearly a thing of the past. In 15 years the greater part of Fergus County has been homesteaded, dozens of postoffices and over a score of good towns and cities have been started. The railroads have made this rapid development possible. Without railroads there might have been a limited export of wool and grain by the Missouri River steamboats and the chief wagon roads would run to boat landings on the Missouri; but the railroads caused as much development in Fergus County, in a decade, as would have resulted in a century without them.

Fergus County is in the geographic center of the state. In the early days we were off the main railroad routes to the north and south and were

at a disadvantage. With the network of roads built in Central Montana in the last few years, however, this central location will have in increasingly favorable influence on wholesaling, retailing and manufacturing in Lewistown and other Fergus County cities. The Missouri River and the "breaks" along it constitute a serious barrier for trade with the counties north, ferrys furnishing the only means of crossing it. The Musselshell is not a serious barrier, especially since the construction of a bridge across it in 1918, and good roads north across the Missouri are being built.

There is considerable water power that can be cheaply utilized near Lewistown, and in the future will be a favorable factor for influencing the location of manufacturing plants.

The great distance from chief world markets will probably restrict manufacturing in Montana to those things for which there is a local demand and that can be made from raw materials locally available, especially such things as do not require a large number of skilled operatives.

In agriculture we shall see fixed farming and dairying become of more importance. When Fergus County's farms are fully developed several times the present number of inhabitants can live comfortably here, and the value of the grain, beef, hogs, and wool produced will be many times that of the present output.

CEMENT PLANT AT HANOVER.

CHAPTER XII.

Origin of the Geographic Names in Fergus County.

Alaska Bench named from its winter climate.

Amherst, the railroad station, and Acushnet, the P. O. nearby, were named for New England towns.

Armells P. O. established about 1913. Armells Creek was named at an early date, probably by the trappers, and appears on the map of Montana in 1870.

Arrow Creek, town named from Arrow Creek, founded about 1913. Creek named in days of freighters and was on map of Montana in 1870. Arrow Creek Hill through the badlands was a famous landmark on the old Fort Benton stage and freight road. Arrow Creek was named by an Indian from its curving course.

Ashley, named for the rancher, Eben L. Ashley, who established a P. O. there in 1915.

Bear Gulch, near Becket, named to commemorate a large bear killed by McCauley there in the spring of the year.

Blacktail Gulch, near Becket, named for deer once found there.

Becket, founded in 1915. Named by railroad officials for no known reason.

Beaver Creek still has many beaver dams along its course. Named by the trappers.

Benchland, named from the character of the farming county nearby. Founded late in 1907.

Big Snowy Mountains, named by the trappers from the heavy snow that usually covers the mountains and often lasts until well into summer.

Black Butte was a landmark of the trappers and freighters and was named in early days from its appearance, as viewed from Northern and Eastern Fergus County.

Blakeslee P. O., named for C. E. Blakeslee, a rancher. Founded about 1914.

Blood Creek was named by the trappers probably from the color of its water. The name appears on a map of Montana in 1870.

Box Elder Creek, probably named from boxelders growing beside the stream. On map of Montana in 1870, hence was named by the trappers.

Brooks, named after John and Henry Brooks, who were old-timers in Fergus County. Henry Brooks managed the Horseshoe Bar Ranch for some years, which is near present town of Brooks. Founded about 1913.

Buffalo, named from Buffalo Creek Valley that in turn was named after the buffalo, common in the Basin until the late seventies. Town was founded in 1907.

Carroll, named for Matt Carroll, an old-timer of Helena. It was a well-known steamboat landing on the Missouri a short distance from the present P. O. of Wilder. When the river was at a low stage steamboats could not get to Benton and landed their cargoes at Carroll from which point freighters hauled the goods across the Basin to Helena for distribution to the mines. Fort Hawley appears on the map of 1870, a few miles east of Carroll, but nothing is known about it.

Casino Creek, in the seventies Peter Koch of Bozeman was in charge of a party engaged in laying out the old Carroll Road. The weather was

bad and they camped some time on one of the creeks and the men played casino and named the creeks Little and Big Casino, from the game.

Casofour, name of U. S. Gypsum Company plant near Heath. Named from chemical formula for gypsum, calcium sulphate (Ca S O4), the ca standing for calcium, S for sulphur, and O4 the amount of oxygen present.

Cat Creek, a tributary to the Musselshell, appears on a map of 1870, and was named by the trappers.

Cheadle, named after E. K. Cheadle, a lawyer of Lewistown. Founded in 1915.

Chippewa Creek was named in 1879 by a military party searching for a site for Fort Maginnis. The party was accompanied by Richard Doyle, nicknamed "Chippewa." One evening when the party was in camp on Chippewa Creek, Doyle saw a jack rabbit in silhouette against the evening sky and made great haste to get his rifle in the mistaken belief that the animal was an elk and the creek was jokingly named in his honor.

Christina, named after Christina Hilger, wife of David Hilger, a pioneer rancher and banker in Fergus County. Founded late in 1913.

Coffee Creek, named from a creek of the same name. Founded about 1915. Creek was named because of the color of the water, which was very dark from alkali.

Cone Butte appears on a map of 1870 and was named by the trappers from its appearance.

Cottonwood Creek, named from occurrence of many cottonwoods along the stream. Named by the trappers.

Cow Island is an old steamboat landing on the Missouri, northeast of Winifred, near the present ferry across the river at the Ruby Gulch Mining Company's power plant.

Crooked Creek was named by the trappers from its course through the badlands. The name appears on the may of 1870. Lewis and Clark named the stream Sacajawea Creek. Little Crooked P. O. named from the creek.

Crystal Lake, name given because of clearness of water and beauty of reflections of the mountains upon its surface.

Danvers, founded in 1913. Named Warwick first and name changed to Danvers since there was already one Warwick in the state. Name suggested by Mr. C. A. Goodenow of the Milwaukee Railway for a New England town.

Deerfield, founded in 1889 or 1890, when the stage road was built from Lewistown to Fort Benton. Named after a town in the Middle West by E. A. Huson.

Denton, present town founded late in 1912. Denton was originally a stage station on the old Lewistown-Benton Road on the ranch of Henry S. Dent, and was started in the early eighties.

Dog Creek, named in the days of the trappers and is on the map of Montana in 1870 as Dog River.

Dovetail Creek and Dovetail Butte were named by the trappers. Dovetail Creek appears on map of 1870. Dovetail P. O. named for the creek.

Everson, named from Ever's ranch that was located about 1890. Post office started later.

Fergus County named after the pioneer, James Fergus. Fergus P. O named after the William Fergus family, whose ranch is near Armells

Formerly P. O. was called Roy, later moved to near present site, when the Peck ranch was sold on which Roy P. O. was located.

Flatwillow Creek was named from its sluggish current contrasted with its chief tributary, called Willow Creek, probably from the trees beside it. Both were named by the trappers and are on the map of Montana in 1870. Flatwillow P. O. named from the creek.

Ford Creek is an old name, appears on land office maps of the seventies.

Forestgrove, founded in early eighties. Named from Forestgrove ranch of Tom Frost, probably named from a grove of cottonwoods on the ranch.

Fort Maginnis, founded by the U. S. Government as a military post in 1880. Abandoned 1890. Postoffice still called by that name. Named after Major Martin Maginnis, who was territorial delegate in Congress for several years.

Garneill P. O., founded 1899. Named from Garnet Courier, later wife of William Neill, a belle of the vicinity, who promised to marry William Neill at the time the choice of a name for a new school district came up and the residents chose a name to commemorate the circumstances. There were two towns, a "dry" and a "wet" Garneill, about a half mile part. When the Montana railroad was built in 1904, both the towns moved to the present site and a new town, the third, was started.

Geraldine, in Chouteau County, named for Mrs. William Rockefeller, mother of Percy Rockefeller, a large stockholder in the C., M. & St. P. Railway.

Gerhard, named after N. J. Gerhard, a rancher. Founded about 1915.

Glengary was founded in 1907, and was named by Angus McMillan after Glengary, Scotland, his native town.

Grass Range, established in 1881. Named from ranch country about it. It was a stage station on the old Fort Maginnis and Junction City Road. Named by Frank Chamberlain, the first owner of the ranch there.

Gilt Edge, founded in 1893. J. T. Armington and T. E. Collins developed the mines and built a cyanide mill. It was named after the Gilt Edge Mining Company, which in turn was named after the Gilt Edge claim, located by William Wilson in 1884.

Half Moon Pass, named from its shape.

Hanover, founded in 1916 because of gypsum mill built there. Named after Hanover, Germany, where cement works are located.

Haystack Butte, in Northeastern Fergus County, named from shape by freighters or trappers. Names appears on may of 1870.

Heath, named after Perry Heath, a rancher. Founded about 1912.

Highwood Mountains, named from timber formerly covering mountains. Name appear on may of 1870 and was given to them by the trappers.

Hilger, named after David Hilger of Lewistown, formerly a prominent rancher of Northern Fergus County. Founded 1913.

Hobson, founded in 1907. Named after S. S. Hobson, once prominent rancher and banker of Fergus County, now living in Great Falls.

Hoosac, named from the tunnel on the Milwaukee Railroad. Founded in 1913. Named after Hoosac Tunnel of New England.

Houck Siding, named after J. C. Houck, a prominent rancher of the Judith River country.

Jones, founded about 1908. Named after William Jones, a rancher.

Judith River, named by Lewis and Clark in 1805, after Julia Hancock of Virginia, later wife of Captain Clark. She was nicknamed Judith. The name Judith Basin was applied to land in the vicinity of Judith River. Judith Mountains, derived from vicinity of Judith Basin. Judith P. O. established in 1885. An old fort was built near the mouth of the Judith River in the forties and later in the sixties and seventies soldiers were stationed here during periods of navigation on the Missouri, and the location was called Camp Cooke. Camp Cooke was first military post in Montana, started 1866 when low water prevented soldiers reaching Fort Benton. Power's built Fort Claggett in 1871, but abandoned it later. The place was called Claggett until about 1890. Named for William H. Claggett, one of the early delegates in Congress from Montana.

Kachia, founded in 1915. A seed catalog was consulted to find a name for the new postoffice, and Kochia was chosen, but was misread in the department at Washington and the name came back Kachia.

Kelly was founded in 1916. Named for Harry Kelly, receiver of the land office at Lewistown.

Kendall was started in 1898 after the discovery of gold there. Named after the late Harry T. Kendall.

Kolin, founded in 1912. Named by Bohemian settlers in vicinity for a town in Bohemia.

Lehigh, founded in 1915 as a coal mining town. Named after Lehigh, Pa.

Lewistown, derived from Camp Lewis, an old camping site at junction of Big Casino and Sprink Creek, near brewery. Never visited by Captain Lewis. Trading post built in 1873 but moved about two miles down the creek in 1875. Another store built on present site of town in 1879. Reed's Fort P. O. established in 1880. Present name adopted a few years thereafter by F. A. Janeaux when he laid out the townsite of Lewistown on his ranch.

Lindstrom P. O. established in 1913. Named after the rancher who runs the store and P. O.

Little Belt Mountains is an old name. Probably named by the trappers from the long stretch of the mountains along the skyline. Belt Butte, near the city of Belt, was named for a thick bed of white volcanic ash that crops out like a band around it. Belt Creek and the city of Belt were named from the stream and the mountains may have been named from the creek that rises in them. Little Belt Mountains City appears on the map of Montana in 1870, a few miles west of Carroll, but nothing could be learned of it.

Little Snowy Mountains, name was used by the trappers to designate the rough, wooded country east and northeast of the Big Snowy Mountains.

Malden, founded in 1880, when gold was discovered and there are many different stories about the naming of the town. Frank D. Finlaw, of New Year, states that a band of Indians was camped below the mines and the miners always talked of calling on "the dusky maidens," and the town was named from this. Mrs. Connelly, however, wife of Jim Connolly, an early miner in Malden, was the first woman living there and states the camp was named for her daughter. Another version is that it was named after the daughter of a Mr. Sweeney, who was the first child born there. Sweeney is said to have located in the mountains before the mines were

found. William Culver, of Lewistown, the first photographer at Maiden, states that the name was selected by Al Brundage, an old-timer.

McDonald Creek. On map of Montana in 1870, and was named for Henry McDonald, a Canadian Scotchman, now living in New York. He carried mail from Rocky Point to Helena and received $20 per day for it, due to danger from the Indians. In the late sixties McDonald helped a band of Crow Indians defeat a band of Sioux Indians on McDonald Creek and the creek was named to commemorate this. The Indians were fighting over the possession of about 3,000 horses. He laid out several government roads, including one from Rocky Point to Helena. Later he settled on Cottonwood, 60 miles from Lewistown, near Square Butte, and later disposed of this place to Ole Osnes.

Merino, named from the high-grade sheep pastured nearby, and was started about 1908. There was a stage station near the present site of Harlowton named Merino in the eighties.

Moccasin, named from Moccasin Mountains, founded in 1907. There was an old Moccasin P. O. and stage station below the Horseshoe Bar ranch at the crossing of Warm Spring Creek by the Fort Benton Road. Postoffice abandoned after the Montana Railroad was built, and name was adopted for present town.

Moccasin Mountains were named perhaps from their general shape, which resembles a moccasin. Named by the old trappers before the country was settled.

Moore, named after a Philadelphia financier who helped finance the Montana Railroad. Founded in 1904.

Musselshell River, named by Lewis and Clark from shells found in the stream.

N. Bar Ranch was first started in 1880 by Linn and W. T. McFarland, assistants to W. W. DeLacey, a surveyor, as a sheep ranch. The capital was furnished by W. C. Childs, a Wells-Fargo agent, who later took over the ranch, and it was called the Child ranch. Later it was bought by Thomas Cruse and named the N. Bar and became one of the famous cattle ranches of Montana.

Natal, founded about 1908. Probably named after the South African country.

New Year, named from New Year mine, located by A. D. Harmon on New Year's day in late eighties.

Novary, named after the Novary products of a wholesale company in Lewistown. Founded as Wint about 1915. Name changed in 1917.

Pinegrove, named from pine forested hills about the postoffice. Founded about 1900.

Philbrook, founded about 1881. Named by E. J. Morrison after the maiden name of Mr. Morrison's mother. The first storekeeper at the Fort Benton and White Sulphur Springs crossing of the Judith was J. L. Clegg, who soon sold out to Morrison. Site abandoned in favor of Hobson, four miles down the river, when the Great Northern was built in 1907.

Piper, named after Harley Piper, a rancher. P. O. started in 1916.

Plum Creek, named from a grove of wild plum trees P. O. established a few years ago.

Pownal, named for a New England town.

Rock Creek, name results from stony bed along part of its course.

Ross Fork, founded about 1912. Named after Ross Fork of Judith River, which in turn was named in the days of the trapper, probably after an old trapper.

Roy, founded in 1892 at the ranch of W. H. Peck, who aimed to call the P. O. Ray, but due to a mistake at Washington, it was called Roy. Present town of Roy is seven miles from the old Peck ranch, and was founded in 1913. Postoffice moved to about two miles of the present site, when Peck ranch was sold and later moved when railroad was built.

Sacajawea Creek, named by Lewis and Clark after the Indian woman guide, now called Crooked Creek. An attempt was made to change the name by legislative action back to Sacajawea Creek during the Lewis and Clark Exposition. The bill passed the house of representatives at Helena but was killed in the senate when the sponsors of the bill were asked to pronounce the name and were unable to do so.

Sage Creek, named from sagebrush along it.

Sapphire, named after sapphire mines. Mines located by Jacob Hoover, S. S. Hobson and Dr. J. A. Bovet about 1894.

Smith, founded about 1915. Named for Sam Smith, who owned the ranch where the P. O. was established.

Square Butte, named from precipitous sides and square edge of the mountain. Round Butte, between Square Butte and the Highwoods, named from its shape. This is called Palisade Butte on the U. S. G. S. map.

Stanford, named from Old Stanford that was an old stage station and cow town, founded about 1880. Present town founded in 1907, when the Great Northern Railroad was built, and is located about two miles from the old site. Another P. O. called Dubuque existed on the site of Old Stanford on T. E. Morgan's ranch. Name was changed after Morgan died and the Stanford P. O. was moved to the site of Dubuque. Stanford, named from Stanford, N. Y., by the Bower Bros., who settled on Surprize Creek in 1880. The first P. O. was on Baylis & Robley's ranch, later owned by Col. T. A. Vial and at present by the Long Investment Co.

Straw was founded in 1904. Named after W. O. Straw of Bethel, Maine, who formerly owned a ranch that included the site of the town. Montana Railroad called a station Ada at the site of Straw until P. O. was established.

Surprize Creek, named from the fact that when first found it flowed across a prairie and could not be seen until one was close to it.

Suffolk, founded in 1914. Name chosen by C. A. Goodenow, assistant to the president of the C., M. & St. P. Railroad, after a town in New England. The first name chosen was Swope, after a pioneer, but this was soon changed.

Teigen, named after M. P. Teigen. Founded in 1914.

Two Calf Creek, named in days of free range.

Tyler, named after Charles Tyler, a rancher. Founded about 1900.

Ubet, founded about 1881 as a stage station, one and one-half miles from Garneill. Named after following occurrence: A. R. Barrows and wife set a good table and many stopped over night. When Judge Sanders, a Republican, was campaigning for territorial delegate against Major Martin Maginniss he stayed over night at the Barrows ranch and sounded

some teamsters about their politics, but found they were all Democrats. When asked if they would like to sample the contents of a brown jug they exclaimed, "You Bet!" He replied, "You bet this is only for Republicans," and drove off. A postoffice was soon after established and was named from the Sanders incident, as Barrows wanted a short name for the P. O. as he had had experience with towns with long names and he knew they took a lot of time to write.

Utica, founded in 1879. Named from Utica, New York. Chosen by Joe Culling, the first postmaster there. Culling was from Utica, New York, and ran the first store there, which had been established by J. D. Weatherwax, an old freighter. Mr. T. J. Waddell of Stanford states that the postoffice was established March 5, 1881.

Valentine, founded about 1914. Named after Valentine Springs, which was named by freighters and hunters, or by the first owner of the property.

War House Lake, named by Walter Winnett from Indian war houses, built in timbered by the shore of the lake. They were built of pitch pine logs and Winnett used them in fencing his ranch.

War House Butte, north of Teigen, at the head of Bear Creek, was named from a battle that occurred at that place between two hostile bands of Indians. One party strongly fortified the Butte with log war houses that were too strong to be successfully attacked by the other party, which retired.

Ware, named for a New England town by the Milwaukee officials.

Weede, postoffice founded in 1901. Named after Ed Weede, a rancher of that vicinity.

Wild Horse Lake, name originated before the days of the free range, from a band of wild horses in the vicinity, often caught by the first settlers.

Windham, founded in 1907 when the Great Northern was built. Named from Windham County, Vermont, the birthplace of L. H. Hamilton of the Sage Creek Sheep Co., whose ranch included the site of Windham.

Winifred, named after the eldest daughter of Mr. Percy Rockefeller, on of the largest stockholders in the Milwaukee Railroad. Postoffice established December 8, 1913.

Winnett, named after Walter J. Winnett, a prominent rancher who had a ranch there since the eighties. Postoffice established in 1910. Town lots were sold July 18, 1914.

Wolf Creek, named in the early days. Running Wolf flows the year around; Dry Wolf usually fails to flow in the winter. Possibly named by Lewis and Clark or at least by some of the first fur traders.

Yogo. Gold discovered there in 1879, but abandoned a few years later. It is an Indian name, the literal meaning of which would not look well translated into English. Named by Jake Hoover.

CRYSTAL LAKE.

INDEX

INDEX (CONTINUED)