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The primary purpose of this soil reconnoissance of Montana is to obtain general information in regard to (1) the soil resources of the state, (2) the adaptability of the topography to agriculture, and (3) the carrying capacity of the different soil areas for livestock. Such a survey is of a general nature and the areas shown on the soil and topographical maps simply represent the prevailing character of the soil and topography.

The Glacier County report is the tenth to be issued. Reports on Sheridan, Daniels, Roosevelt, Valley, Phillips, Blaine, Hill, and Liberty and Toole counties are also available and may be obtained from the Montana Experiment Station, Bozeman, Montana.

# SOILS OF GLACIER COUNTY

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## LOCATION

Glacier County is located in the western part of north-central Montana. The Canadian line forms its northern and the continental divide its western boundary. The portion of the county covered by mountains lies within Glacier National Park and the Lewis and Clark National Forest. The Blackfeet Indian Reservation covers about 70 per cent of the total area of the county. Glacier County was created from portions of Teton and Pondera counties in 1919.

Glacier County covers a total area of 3,045 square miles. It is between Townships 30 and 37 North of Base Line Montana, and Ranges 4 and 18 West of Principal Meridian, Montana. Glacier County borders Canada for a distance of 75 miles and has a maximum width of approximately 48 miles. It has the same general shape as the state of Montana, except for a rectangular block cut out of its southeastern corner.

## PHYSIOGRAPHIC FEATURES

Most of Glacier County covers a transitional foothill area between the Great Plains to the east and the mountains to the west. High, stony plateaus, traversed by wide stream valleys, lie in front of the mountains. The central part of the county is a rolling, residual area, with the higher ridges and hills often capped with quartzite gravel. The eastern part is a drift-covered plain, dissected with deeply entrenched streams.

**GLACIATION.**—During the Wisconsin Glaciation, probably the Late Wisconsin, the main divide of the Rocky Mountains was a collecting ground for glaciers. On the eastern slopes of the mountains the glaciers pushed down the canyons and deployed on the table-lands and in the stream valleys. In the northwestern part of the county the valleys of St. Mary's River and other streams were filled with ice. In the west-central part of the county and within 10 to 12 miles of the mountains the ice moved down the canyon of Cut Bank Creek and deployed in the valley of this stream and on the plateau at the head of the South Fork of Milk River. In the southwestern part of the county the glaciers that were formed in the canyons of Badger, Two Medicine, and Blacktail creeks united below the mountains and extended east 30 miles or more past Four Horns Lake. The Keewatin or continental ice sheet extended into the eastern and northern parts of Glacier County. The drift of the continental ice sheet overlies the mountain drift in the vicinity of Four Horns Lake. Glacial lake and outwash deposits occur in front of the continental ice sheet drift along Rocky, Cut Bank, and other creeks. Gravelly valley trains occur in some of the valleys of the larger mountain streams, such as Cut Bank Creek.

The eastern limits of the mountain glaciers are defined by high, stony morainic ridges, such as are found (1) between Family and Bombay, (2) along Cut Bank Creek west of Bombay, (3) at the head of the South Fork of Milk River, (4) east and south of Duck Lake. South of Cut Bank Creek in the vicinity of Browning and Kipp are several stony recessional ridges, separated by poorly drained, gravelly lake basins. The drift of the mountain glaciers is very stony and consists largely of red, green, and black argillite and red and white quartzite. It is very hummocky and near the mountains fresh-water lakes are numerous. The southwestern limit of the continental ice sheet is also well defined in the northern part of the county. Stony hummocky ridges extend north from Baltic to Hay Lake and then strike northwest to the Middle Fork of Milk River. The ice of this glacier also extended into the basin along Willow Creek and formed the stony hummocky ridges below the high benches north of the North Fork of Milk River. The drift of the continental ice sheet contains boulders of granitic rock which are seldom found in the mountain drift. Along the Canadian line the drift has a morainic topography and in the basin along Willow Creek the pot-holes are filled with water. In the southeastern part of the county the drift has a more gentle relief, commonly described as a "swell-and-saucer" type of topography. It becomes more hummocky to the west and around Four Horns Lake grades into the morainic ridges of the mountain drift.

The drift of the mountain glaciers was largely deposited in recessional ridges and is therefore of variable depth. The covering of drift increases towards the mountains and in the valleys of some of the preglacial streams it is several hundred feet thick. Along the Canadian line the drift of the continental ice sheet is also of variable depth. Differences of 100 feet or more often occur between the surface of the pot-holes and the tops of the morainic ridges. The covering of drift in the southeastern part of the county does not greatly exceed 20 to 25 feet. The mountain drift covers an area below the mountains varying in elevation from 4,000 to 6,000 feet, and the areas covered by the drift of the continental ice sheet vary from 3,700 to 4,300 feet in the eastern part of the county to 4,500 to 5,000 feet in the basin along Willow Creek.

**MOUNTAINS**—The continental divide in northwestern Montana extends in a southeasterly direction and lies within 10 to 30 miles of the high plateaus east of the mountains. According to Calhoun,\* the front range of the Rocky Mountains, known as the Lewis Range, was formed by a fault, which thrusts 8,000 to 10,000 feet of sedimentary rock of Algonkian age obliquely up and over shales and sandstone of the Upper Cretaceous age for a distance of seven miles or more. The rock found in the mountains consists chiefly of hard

\*Calhoun, Fred H. H. The Montana Lobe of the Kewatin Ice Sheet. U. S. Geol. Survey, Professional Paper No. 50. 1906.

resistant limestones, argillites, quartzite, and conglomerites, except in Swift Current Canyon, where an intrusion of diorite occurs in the sedimentary rocks. The mountains rise rather abruptly 3,000 to 5,000 feet above the plateaus and are eroded into sharp, barren peaks and serrated ridges. The more prominent peaks rising above the plateaus are Chief, Divide, and Rising Wolf. These peaks are 8,000 to 9,000 feet in elevation and average 1,000 feet lower than those on the continental divide. At the higher elevations the circular valleys bordered by high precipitous walls are often covered with snow and ice throughout the year. Some of these ice fields cover tracts of 3 to 5 square miles at the head of St. Mary's River and its branches. The mountain slopes are broken with deep narrow U-shaped canyons down which the glaciers moved. Numerous lakes, fed by local glaciers, are found on the wooded mountain slopes and in the canyons. Finger lakes, such as Upper and Lower St. Mary's and Two Medicine, occur in the larger stream valleys.

**PLATEAUS**—The stony plateaus, traversed by wide stream valleys, east of the mountains, have smooth, plain surfaces and slope gently to the east. These plateaus lie 900 to 1,000 feet above the level of the streams and have about the same grade as the present stream valleys. Near the mountains the plateaus are from 1 to 5 miles wide; to the east they narrow into ridges, which in turn give way to buttes and stony capped hills in the central part of the county. The plateaus range in elevation from approximately 4,300 feet along the Canadian line, north of the South Fork of Milk River, to 6,200 feet on the St. Mary's and Milk River ridges, east of Divide Mountains. The protecting covering of these plateaus is chiefly well-rounded water-worn resistant quartzite and argillite gravel and rock ranging from 1 to 6 inches or more in diameter. The gravel covering is of variable depth and was laid down before the time of the last glaciation. It should probably be associated with similar quartzite gravel deposits of Tertiary age found in other parts of the state. A portion of these plateaus forms the divide known as St. Mary's Divide between St. Mary's River and the Middle and South Forks of Milk River and also the divide known as Milk River Ridge between the South Fork of Milk River and Cut Bank Creek. Milk River Ridge, which is flat-topped, is located south of the South Fork of Milk River and extends northeast as far as the mouth of the Middle Fork. Remnants of these plateaus occur below the Canadian line east of St. Mary's River and north of the North and South Forks of Milk River. In the central part of the county, north of Cut Bank Creek, quartzite gravel and rock cap the higher hills and slopes between elevations of 4,300 and 4,500 feet. South of Cut Bank Creek quartzite gravel deposits outcrop below the drift on the bench east of Four Horns Lake and on the Cut Bank-Two Medicine divide in R. 6 W.

**SEVILLE BENCH OR CARLOW FLAT**:—West of Cut Bank is a large bench bordering the valley of Cut Bank Creek on the south. It is

about 14 miles long by 3 miles wide and slopes gently to the east. It has an elevation of 3,800 to 4,100 feet and lies 75 to 100 feet above the valley of Cut Bank Creek. It has a plain surface with low gravelly bars rising 1 to 2 feet above the general level in the western part. The stratified quartzite gravel deposit, overlying shales and sandstones, is 5 to 20 feet thick on the bench. This bench occupies a later erosional level than the high plateaus in front of the mountains, but was eroded to its present level before the time of glaciations. The sags in the bench are not well drained and since the development of irrigation many of them have become seeped.

**OTHER BENCHES.**—A bench covered with stony outwash from the Cut Bank glacier lies between Greasewood and Cut Bank creeks, north of Browning. The bench has a plain surface with low stony ridges rising 1 to 3 feet high above the general level. It lies between 4,400 and 4,900 feet above sea level and slopes to the east for 9 or 10 miles. The bench has good drainage except for a few sags in the western part below the moraines.

A similar stony outwash covers the basin in which the North Fork of Milk River is entrenched, 100 to 150 feet east of Duck Lake. The basin slopes in the direction of the stream and has an elevation of 4,300 to 5,000 feet. It is broken with deep coulees and below the slopes of the high table-lands it is locally quite rolling. The stony covering is not evenly distributed and residual material derived from red shales outcrops in the coulees and on the rolling slopes. In the lower part of the basin the outwash becomes more gravelly, and below the Canadian line are a few tracts of loose gravel. The basin has good drainage except for a few depressions at the head of the coulees. The valley of the South Fork of Milk River below the Canadian line is also bordered on the north by similar benches or terraces. The covering on these benches consists largely of rock and gravel similar to that found on the high table-lands.

**ANCIENT STREAM VALLEYS.**—Ancient stream courses occur in different parts of the county. Some of these courses are of preglacial origin, while others were formed during the time when the streams were diverted by ice. In T. 37 N., R. 7 W., is a poorly drained gap one-fourth to one-half mile wide, bordered by high sandstone cliffs, which connects the South Fork of Milk River with Rock Creek. Below the sandstone escarpment west of Croffs and Buffalo lakes is a poorly drained alkali basin connecting the South Fork of Milk River with Little Rocky Creek. The upper part of the basin is covered more or less with stony glacial drift, but the lower part is a broad heavy alkali flat. In the south-central part of the county Flat Coulee drains another gap running northwest from Family on Two Medicine River to the head of Spring Creek. The gap is one-half to one mile wide and is bordered by high stony moraines, below which shales and sandstones outcrop on the east. In the central part of the county Cut Bank Creek was diverted from its preglacial

valley by the mountain glaciers. South of this creek is a basin about 15 miles long by 1 to 2 miles wide, covered with glacial outwash gravel. Other streams were also locally diverted by the ice sheets in other parts of the county. The sags between the high stony benches north of the North Fork of Milk River are also called "gaps."

**ESCARPMENTS.**—In the western part of Toole County is a bold sandstone escarpment formed by a fault of several hundred feet. This escarpment swings to the west for about 6 miles across the Glacier County line in the east-central part of the county. South of Hay Lake is another prominent sandstone escarpment running northwest past Headlight Butte. It is probably not a fault but the result of erosion. In the central part of the county the sandstones of the Lance formation rise as a broken escarpment above the Pierre shales. This escarpment extends north from Rimrock Buttes past Horse Thief Ridge to the South Fork of Milk River west of Croffs Lake.

**BAD-LANDS AND BUTTES.**—South of the South Fork of Milk River in the north-central part of the county, two tracts of bad lands are shown on the maps. The dark-colored shales exposed on the western tract are eroded into barren, gullied clay hills and ridges above alkali flats. The eastern tract is eroded into high ridges and buttes, capped with sandstones. Landslide Butte has an elevation of 4,654 feet. In the southern part of the county, north of Two Medicine Creek, are also several small tracts of bad lands. The sandstones exposed on these tracts are eroded into barren ridges and buttes broken with deep coulees. The higher buttes have elevations of 4,200 to 4,300 feet and lie 200 to 300 feet higher than Hagen's Flat to the north. In the central part of the county Horse Thief and Rimrock buttes have elevations of 4,600 to 4,700 feet and lie 300 to 600 feet higher than the area to the east. At the head of Little Rocky Creek, Red Buttes stand out prominently at an elevation of 4,800 feet and their red shaly slopes are gullied and quite barren. Chalk and other buttes are isolated sandstone capped buttes east of the sandstone escarpment in the central part of the county.

#### DRAINAGE

Northwestern Montana lies in three continental drainage basins—the Pacific, the Hudson Bay, and the Gulf of Mexico. Water falling on the eastern slopes of the continental divide in the northern part of Glacier County flows north into Hudson Bay, and in the southern part, south into the Gulf of Mexico. St. Mary's Divide and Divide Mountain separate the two drainage basins. West of St. Mary's Divide the drainage is chiefly into St. Mary's River, but east and south of the divide it is into such streams as the Forks of Milk River, Cut Bank, Two Medicine, and Badger which unite to form several large streams before entering Missouri River. In Glacier County the drainage was not greatly influenced by the mountain and conti-

mental ice sheets. The streams were locally diverted, but most of them returned to their preglacial valleys after the ice receded.

**ST. MARY'S RIVER.**—St. Mary's River, a tributary of Saskatchewan River in Canada, heads on the continental divide in the west-central part of Glacier County. It extends in a northeasterly direction and south of Babb emerges from several long finger lakes, such as Upper and Lower St. Mary's, on to an outwash gravel flat about one mile in width north of Kennedy Creek. It flows through a drift-covered basin between the mountains and a high bench south of the Canadian line. The stream has eroded a deep narrow valley in the eastern part of this basin below the benches. The mountain slopes, heavily covered with timber, rise steeply from the gravelly flat and shores of the lake. East of St. Mary's Lake the morainic and sandstone escarpment of St. Mary's Divide rises 1,000 to 1,500 feet within 2 miles of the lake. North of the divide is a hummocky depression about six miles wide bordering the gravelly flat on the east, south of the high bench. The larger streams entering St. Mary's River are Swiftcurrent and Kennedy creeks. These streams are fed by mountain glaciers on the continental divide and flow east through deep valleys. Between Many Glaciers and the park boundary the valley of Swiftcurrent Creek averages three-fourths of one mile wide. Swiftcurrent Creek and its branches flow through a number of finger lakes, of which the Sherbourne Lakes are storage reservoirs for the Milk River Irrigation Project. East of the park line the stream enters an enclosed canyon above the gravelly flat. Other streams, such as Belly and Waterton Rivers, rise on the continental divide and flow north through finger lakes into Canada. The stony valleys of these streams vary from one-fourth to one mile wide and are bordered by steep wooded mountain slopes. The branches of Lee Creek head on the slopes of Chief Mountain and flow north through deep timbered canyons.

**FORKS OF MILK RIVER.**—The North Fork of Milk River heads in the morainic sag north of St. Mary's Divide and flows northeast into Canada. It is a small perennial stream flowing through a deep, narrow valley entrenched in a wide stony basin between the high benches. South of the Canadian line the supply canal of the Milk River Irrigation Project enters it and during the summer months its volume is greatly increased.

The South Fork of Milk River heads on Milk River Ridge east of Divide Mountain. It is a larger stream than the North Fork and also flows northeast, crossing the international line in R. 7 W. East of Divide Mountain it has eroded a valley more than 500 feet deep in the stony plateau. A tongue of this plateau rises as a high bench above the river on the south and as far as the mouth of Middle Fork. Similar benches, but with terraced slopes, lie above the stream below the Canadian line in the north-central part of the county. The area west of Croff's lake and above the sandstone escarpment is a rolling

upland, grading into gravelly terraces along the stream. In R. 8 W. the stream enters an enclosed valley, bordered on the north and east by drift-covered uplands and on the south by sandstone ridges and bad lands. North of Fox Creek in R. 13 W. the valley of the South Fork is about one-fourth mile wide, and from the mouth of Livermore Creek to its enclosed valley in R. 8 W. it is from one-half to one mile wide. The bottom of this stream above the mouth of the Middle Fork is a flat wet meadow, but below it varies from poorly drained alkaline clays to sandy gravelly terraces. Toad, Fox, and Livermore creeks are small perennial streams, heading on St. Mary's Divide and entering the stream from the west. The bottoms of these streams are narrow and poorly drained. The intermittent streams entering the river from the south head within 2 to 5 miles of the river. A few of them have perennial springs along their courses.

The Middle Fork of Milk River heads on St. Mary's Divide and flows east, entering the South Fork in R. 11 W. It is a small perennial stream, flowing through a flat swampy bottom one-fourth to one-half mile wide below the plateau. A narrow gravel-capped bench forms the divide between the North and South forks. The area east of the plateau between the Middle and South forks is quite rolling, with local outcrops of red sandstone and shale on the more eroded slopes.

Several other branches of Milk River and its fork head in the northern part of the county and flow northeast into Canada. Willow Creek heads in Spider Lake, located in a gap east of St. Mary's River, below the high bench. It drains a morainic basin between the high benches in Ranges 12 and 13 W. It flows through an open poorly drained valley, in which are located several small lakes. Red River rises in the northeastern part of the county. It is an intermittent stream draining a drift-covered upland above a heavy basin along the branches of the stream.

**CUT BANK CREEK:**—Cut Bank Creek is one of the larger streams in Glacier County. It heads on the continental divide in the west-central part of the county and takes an easterly course as far as R. 6 W., where it turns sharply to the south, leaving the county in the southeastern corner. It has eroded a valley 1,000 to 1,500 feet deep through the stony plateau, which rises above the stream as the Milk River and Cut Bank ridges. Below the plateau the stream passes through a morainic section lying west of the bench between Cut Bank and Greasewood creeks. Its valley is entrenched 100 feet or more below the bench and the morainic ridges on the south. East of the bench the valley is 2 miles wide for about 6 miles and is bordered by moraines on the south and by gently sloping uplands on the north. In R. 9 W. it leaves the preglacial valley and enters a more enclosed one, varying from one-half to three-fourths mile wide, bordered by sandstone and gravel-capped hills. It returns to its gravelly preglacial valley 2 to 3 miles wide in R. 8 W. South of this portion of the valley rises the Seville bench on the south and a gently sloping

gravelly upland on the north. In R. 6 W. it enters a sandstone canyon 100 feet or more deep and follows it to the county line. The recent bottom of Cut Bank Creek consists largely of wash gravel carried down from the mountains.

The larger perennial streams entering Cut Bank Creek from the north in the central part of Glacier County are Greasewood, Trail, Cabelle, and Powell. These streams drain a rather sharply rolling area, characterized by gravel-capped hills and ridges east of the high benches and by sandstone ridges and buttes in the central part. Trail and Powell creeks are enclosed in narrow valleys, while Greasewood and Cabelle creeks have more open valleys. The bottoms of Greasewood and Cabelle creeks widen out locally to one-fourth to one-half mile. All streams have heavy alkaline bottoms. Little Rocky Coulee is a perennial stream except in very dry seasons. It heads on the eastern slopes of Red Buttes and flows southeast, entering Cut Bank Creek about 6 miles northwest of Cut Bank. East of the sandstone escarpment in the central part of the county it flows through a wide basin bordered by rolling uplands. Its bottom is heavy and alkaline along most of its course. Rocky Creek heads in the morainic ridges east of the South Fork of Milk River and flows south, entering Cut Bank Creek a few miles east of the mouth of Little Rocky Coulee. It is a small perennial stream enclosed in a deep sandstone canyon below the moraines. It drains a drift-covered area in the northeastern part of the county. One branch of this stream heads in the gap connecting the South Fork of Milk River with Rocky Creek. Snake Creek is an intermittent stream heading below the sandstone escarpment south of Hay Lake. It flows southwest and enters Cut Bank Creek north of Cut Bank. It drains a gently sloping outwash section below the sandstone escarpment and the stony moraines to the east.

The more important perennial streams entering Cut Bank Creek from the south are the South Fork of Cut Bank Creek, and Spring Creek. The former heads on the eastern slopes of the continental divide and flows east through a wide morainic basin between Cut Bank and Two Medicine ridges. Below the basins it passes through morainic ridges, entering Cut Bank Creek at the Cut Bank Agency or Hospital. Willow Creek rises on the eastern slope of Two Medicine Ridge and flows northeast through a gravelly glacial lake basin, below high morainic ridges. It enters Cut Bank Creek a few miles northwest of Bombay. West of Blackfoot is a large swamp extending west and north of Browning. Spring Creek heads in a gap south of the Seville bench and flows east through a wide heavy alkaline basin, entering Cut Bank Creek south of Cut Bank. It is a small perennial stream draining a wide basin below the bench on the north and a broken escarpment lying north of a high rolling drift-covered area on the south.

**TWO MEDICINE CREEK:**—Two Medicine Creek is also one of the larger streams in Glacier County. It heads on the continental divide

in the southwestern part of the county and flows northeast through several finger lakes, such as Upper and Lower Two Medicine. After emerging from the lakes its course is to the southeast and east through a deep canyon bordered by shaly breaks for 6 to 7 miles east of Glacier Park station. In the south-central part of the county its course is again to the northeast and east through a deep narrow valley locally bordered with sandstone breaks below the stony hummocky drift-covered uplands. Below the mouth of Little Badger Creek its valley is from one-fourth to one-third mile wide, and east of Family for 4 to 5 miles is about 2 miles wide. A low terrace or island extends east of Family for about 4 miles and is bordered on the north by a poorly drained bottom one-half mile wide. The valley again closes up to the east along the county line and is bordered by high sandstone breaks and bad lands on the north. Locally, below the breaks, the valley widens out and its rolling terraced bottom is quite stony.

Summit Creek is a small perennial stream flowing through a deep canyon and entering Two Medicine Creek south of Glacier Park station. The South Fork of Two Medicine Creek is a large stream draining a large tract on the eastern slopes of the continental divide. It also flows through a deep canyon below a stony bench and joins Two Medicine Creek 6 miles east of Glacier Park station. Little Badger Creek rises in a morainic area on the eastern slopes of the continental divide and enters Two Medicine Creek in the south-central part of the county through a deep narrow valley. Flat Creek heads in a gap northeast of Family. It is an intermittent stream draining a sharply rolling drift-covered area above the breaks of the gap.

**BADGER CREEK:**—Badger Creek carries about the same volume of water as Two Medicine Creek. It heads on the continental divide in Pondera County and flows northeast through a rolling to sharply rolling drift-covered area, entering Two Medicine Creek west of the county line in R. 8 W. The stream is enclosed in a deep canyon on the slopes of the mountains, but in the south-central part of the county its valley widens out to one-fourth to three-fourths of a mile and is bordered locally by sandstone and shaly breaks. Gravelly terraces rise above the stream and its first bottom is largely river wash. Blacktail Creek is a perennial stream entering Badger Creek through a deep valley in the south-central part of the county. It drains a rolling drift-covered area.

**BIRCH CREEK:**—Birch Creek passes through the southeastern corner of T. 30 N., R. 8 W. in a narrow valley bordered by high sandstone breaks. It is a large perennial stream uniting with Cut Bank Creek across the county line to form Marias River.

#### SETTLEMENT

The area north of Marias and Missouri rivers as far west as the main range of mountains was an Indian reservation almost up to the

time of the construction of the Great Northern Railway through this part of Montana. The present boundaries of the Blackfeet Indian Reservation in northern Montana were not established until about 1885 and the unreserved public lands were not thrown open for settlement until 1887. Stockmen moved their herds across Marias River as soon as the unreserved land was thrown open. The area east of the Blackfeet Indian Reservation in Glacier County was not sectionized until late in the nineties.

**HISTORY:**—Captain Meriwether Lewis, of the Lewis and Clark Expedition, ascended Marias River to discover its source in 1806. Captain Lewis reached a point on Cut Bank Creek west of Bombay on the Great Northern Railway where he was turned back by a small band of Blackfeet Indians. The area west of the mountains at this time was in possession of the Blackfeet Indians, consisting of the Piegan and Blood tribes. The Blackfeet Nation was very hostile to American trappers and Indian traders up to about 1842, when the American Fur Trading Company established a permanent post at Fort Benton in the Blackfeet territory. Trappers and Indian traders of the Hudson Bay Company ascended St. Mary's River before this time, but the accounts of their travels are brief.

The chief industry in this part of the state for many years after the Lewis and Clark Expedition was trapping and trading with the Indians. In 1854 the Stevens Expedition was organized to determine the feasibility of building a railway through the Northwest territory. Members of this expedition investigated the mountain passes and snowfall in the mountains the following fall and winter. Later other expeditions were organized to study the resources of the area. These expeditions finally resulted in the construction of the transcontinental railway through Montana in 1883 and 1888. The main line of the Great Northern Railway was completed to Havre in 1888, but through traffic to the coast was not established until several years later.

Among the early military forts and trading posts in the Blackfeet territory, around which some of the local towns have sprung up, are Fort Shaw, Choteau, Dupuyer, Robare, Conrad, Blackfoot, and others on the reservation. The wagon ruts in the prairies of Glacier County show the location of some of the early military and freight trails, such as Fort Macleod Trail, north of Blackfoot through Whiskey Gap into Canada, and also the trail from Fort Shaw to Blackfoot.

**TIME OF SETTLEMENT.**—Stock raising was the chief industry in northern Montana after the land was thrown open for settlement and the Indians were confined to the reservation. Later stock raising was taken up on the reservations, but chiefly by white men. The first settlements in the area were made by squatters around the military forts and trading posts and by stockmen who usually located on the larger streams and in the foothills of the mountains. The till-

able public range land outside of the Indian reservations was largely settled in tracts of 160 and 320 acres between 1910 and 1915.

**SETTLERS:**—The early trappers and Indian traders were largely of French descent. Some of them intermarried with the Indians and a few of their descendants are found on the reservations. The managers of many of the early stock companies were Englishmen and Scotchmen. The people attracted to this part of the state during the dry land movement were largely native-born Americans, who migrated from the industrial centers and agricultural districts of the north-central states. During 1914 and 1915 a few came into north-central Montana from Washington, Oregon, and other western states. A small number of Japanese, Chinese, and Negroes are found in the larger towns.

**POPULATION:**—The farm and urban populations increased with the settlement of the agricultural lands adjacent to the Indian reservations. The development of several irrigation projects on the reservations also attracted a few white settlers. The census report for the year 1930 gives Glacier County a total population of 4,409, about one-half of whom are Indians. The agricultural census of 1925 gave a farm population of 1,650, of whom 871 were Indians.

**TOWNS:**—Cut Bank, the county seat of Glacier County, is located in the southeastern part of the county on the main line of the Great Northern Railway. It has a population of approximately 1,200 and serves a large agricultural area. The Blackfeet Indian Agency is in Browning, a town of about 500 inhabitants located on the main line of the railway in the south-central part of the county. Blackfoot is a small railway town east of Browning and Glacier Park station is one of the official entrances to Glacier National Park. Other stations on the railway are chiefly shipping points. Babb, located in the valley of St. Mary's River a few miles below the Canadian line, is a port of entry. Piegan and Family are subagencies on the reservation. Many Glaciers, St. Mary's, and Two Medicine are pleasure resorts in Glacier National Park. Cut Bank and Browning have standardized schools, but in the country districts the schools are often below the standard required by Montana.

**TRANSPORTATION AND MARKETS:**—The main line of the Great Northern Railway passes through the southern part of Glacier County. It provides facilities for the direct shipment of freight to eastern and western markets such as St. Paul, Chicago, Spokane, and Portland. Most of the exports from the reservation consist of livestock and livestock products such as wool; outside of the reservation it also includes grain. Local markets for perishable farm products are restricted as there are no large industrial centers closer than Great Falls, Butte, and Spokane.

The Roosevelt Highway, also known as the Glacier Trail, parallels the railway through the county as far west as Glacier Park station. An extension of this highway has just been completed through

the park. The Yellowstone-Glacier Park Highway, from Great Falls and Choteau, enters the south-central part of the county and connects with the Roosevelt Highway at Browning. An improved park road runs north from Glacier Park station to Babb and Many Glaciers and also extends north from Babb into Canada, connecting with the Cardston Highway. These roads have crushed gravel surfaces and are maintained in good condition during the tourist season. The road north from Browning into Canada and the Cut Bank-Sweet Grass road are improved, but other roads in the county are often cross country trails, especially on the reservation.

#### BLACKFEET INDIAN RESERVATION

The Blackfeet Indian Reservation covers the greater part of Glacier County. It lies between the Canadian line and Birch Creek in Pondera County and extends east from Glacier National Park and Lewis and Clark National Forest to Cut Bank Creek and a line running due north from it a short distance west of Cut Bank. The reservation covers a total area of 2,750 square miles most of which lies in Glacier County. The land on the reservation has been largely allotted to the Indians except for the tribal timbered lands. Title to land on the reservation may be obtained by purchase from competent Indians and from sale of allotments of deceased Indians. Considerable acreage on the reservation is under lease by several large stock companies. There are approximately 2,000 Indians on the reservation who belong chiefly to the Piegan tribe of the Blackfeet Nation.

#### GLACIER NATIONAL PARK

Glacier National Park was established by an act of Congress in 1910. It embraces a total area of 14,000 square miles, approximately one-half of which lies east of the continental divide in Glacier County. The attractions in the park consist chiefly of rugged mountains, deep canyons, beautiful lakes, glaciers, and roaring streams. Within the boundaries of the park there are more than 250 lakes and 60 glaciers. The numerous mountain passes and trails are blocked with snow until late in the spring.

#### LEWIS AND CLARK NATIONAL FOREST

Lewis and Clark National Forest covers a small area in Glacier County west of the Blackfeet Indian Reservation and south of Glacier National Park. It includes a rough mountainous area heavily covered with timber.

#### STATE LANDS

The area of state lands in Glacier County is approximately 12,000 acres, all of which is included in the state school lands. The sale or lease of these lands is in charge of the Registrar of State Lands, State Capitol, Helena, Montana. A minimum price of ten dollars per acre has been placed on these lands by legislative enactment.

## CLIMATE

The climate of Glacier County is semi-arid. It is influenced by the elevation and by the mountains. The plains of the county are characterized by a low rainfall, great temperature extremes, large number of sunshiny days, and a low relative humidity. The mid-summer temperatures are not oppressive and the winter extremes are not especially severe since they are seldom accompanied by strong winds.

The normal, monthly, seasonal, and annual temperatures at Cut Bank, Browning, and Babb are tabulated in table 1. The weather at these stations has been recorded since 1903, 1894, and 1907, respectively. Their elevations are 3,749, 4,366, and 4,461, respectively.

TEMPERATURES:—The average annual temperature ranges from 38.1°F. at Babb to 40.3°F. at Cut Bank. January, with averages of 16°F. and 17°F., is the coldest month and July with 60°F. to 63.3°F., is the warmest. The lowest minimum temperatures recorded at the stations vary from -41° F. to -56°F. and the maximum from 96°F. at Browning to 100°F. at Babb. The average frost-free period at Cut Bank is from May 18 to September 16 and at Browning from June 4 to October 1. Temperatures of 32° and lower have been reported at all the stations in every month in the year. In the eastern part of the county small grains are usually seeded late in April and early in May. These grains are rarely injured by late spring frosts, but

TABLE 1.—TEMPERATURE

Months	MEAN			ABSOLUTE MAXIMUM			ABSOLUTE MINIMUM		
	Babb 1906-1929	Browning 1894-1929	Cut Bank 1903-1929	Babb	Browning	Cut Bank	Babb	Browning	Cut Bank
December .....	19.0	19.8	19.2	60	62	60	-42	-41	-29
January .....	16.0	16.5	17.0	55	57	57	-46	-56	-46
February .....	18.1	18.6	20.0	58	65	62	-53	-46	-45
Winter .....	—	—	—	60	65	62	-53	-56	-46
March .....	25.9	27.0	28.0	64	71	72	-28	-34	-30
April .....	37.9	38.5	40.5	84	91	87	-8	-13	-1
May .....	46.2	46.9	49.0	84	93	86	3	11	13
Spring .....	—	—	—	84	93	87	-28	-34	-30
June .....	54.2	55.4	57.3	92	98	96	23	21	27
July .....	60.0	61.0	63.3	95	99	99	30	24	34
August .....	58.5	59.2	61.8	96	98	98	27	23	25
Summer .....	—	—	—	96	99	99	23	21	27
September .....	51.0	51.4	52.3	89	90	88	14	9	4
October .....	41.4	41.9	42.1	81	81	79	-20	-17	-14
November .....	29.3	29.6	30.2	68	70	69	-31	-39	-29
Y'all .....	—	—	—	89	90	88	-31	-39	-29
Total .....	38.1	38.8	40.3	96	99	99	-53	-56	-46

early fall frosts may occasionally damage late seeded grains and the more tender crops such as corn and potatoes.

PRECIPITATION.—The precipitation in Glacier County varies with the elevation and location. In the lower plains area of the county the average annual precipitation is 10.99 inches at Cut Bank, and in the area bordering the mountains it ranges from 15.45 inches at Browning to 19.90 inches at Babb. At Cut Bank the extremes in precipitation range from 5.59 to 20.99 inches and at Babb from 14.24 to 33.62 inches. May and June are normally the months of greatest rainfall, each averaging between 2 and 3 inches at Browning and Babb, but at Cut Bank the records show June and July to be the months of greatest rainfall. The amount received between March 1 and September 1 averages between 65 and 75 per cent of the total rainfall at all the stations. The average annual snowfall varies from 19.1 inches in the plains area at Cut Bank to 90.3 inches in the valley of Marias River at Babb.

TABLE 2.—PRECIPITATION

Months	MEAN			TOTAL AMOUNT FOR DRIEST YEAR			TOTAL AMOUNT FOR WETTEST YEAR			SNOW, AVERAGE DEPTH, INCHES		
	Babb 1906-1929	Browning 1894-1929	Cut Bank 1903-1929	Babb 1926	Browning 1920	Cut Bank 1919	Babb 1927	Browning 1896	Cut Bank 1927	Babb	Browning	Cut Bank
	December	1.00	0.71	0.28	1.38	T	0.05	1.23	0.37	0.71	9.4	6.4
January	1.26	.86	.43	.14	1.31	.32	1.11	1.35	1.22	15.1	7.8	4.9
February	1.00	.70	.34	.26	.26	.48	1.81	.48	.60	10.3	7.7	4.9
Winter	3.26	2.27	1.05	1.78	1.57	.85	4.15	2.17	2.53	34.8	21.9	11.0
March	1.20	.90	.35	.87	.22	.00	.76	1.50	.40	10.0	10.6	1.7
April	1.72	1.04	.65	.41	1.33	.00	2.45	1.41	.58	13.2	7.4	1.7
May	2.50	2.30	1.65	.50	1.07	1.39	10.14	5.09	7.01	7.8	6.0	0.2
Spring	5.42	4.24	2.65	1.78	2.62	1.39	13.35	8.00	7.99	31.0	21.0	3.6
June	3.17	2.61	2.43	2.59	.24	.68	1.21	1.34	2.76	.1	.9	.0
July	2.17	1.60	1.84	1.03	1.71	T	3.45	1.38	2.03	T	.1	.0
August	2.03	1.41	1.32	2.24	.97	1.58	2.71	2.74	1.83	.1	.2	.0
Summer	7.37	5.62	5.59	5.86	2.92	2.26	7.37	5.46	6.62	.2	1.2	.0
September	1.92	1.68	1.05	4.23	T	.71	5.82	6.02	1.56	7.2	5.4	1.4
October	1.10	.99	.47	.10	T	.35	1.01	.98	.97	7.6	6.6	1.6
November	.92	.85	.18	.49	T	.03	1.92	3.65	1.32	9.5	8.0	1.5
Fall	3.94	3.52	1.70	4.82	T	1.09	8.75	10.65	3.85	24.3	20.0	4.5
Total	19.90	15.45	10.99	14.24	7.11	5.59	33.62	26.28	20.99	90.3	67.1	19.1

WIND:—Glacier County is subject to strong and persistent westerly winds, which are usually more severe during the early spring months and may do considerable damage to early seeded crops in dry seasons. At the lower elevations chinooks or warm winds often occur

during the winter months and clear the winter grazing lands of snow. Hot winds rise occasionally from the southwest during dry seasons and may cause serious crop losses in the lower plains area of the county. Hailstorms of more or less severity occur locally during the summer months.

#### MAPS

The four maps accompanying this report show (1) the location and extent of the different soils, (2) the main physiographic and geographic features, (3) the location and percentage of each section under cultivation, and (4) the United States geological land classification, which indicates the adaptation of the land to agriculture.

**SOIL MAP.**—The soil map accompanying this report is based on the properties found in the soil under field conditions. It shows the relationship of the soils in different parts of the county. A soil section, such as is found in road cuts and in coulees, shows distinct layers or horizons, which can not be attributed to the origin and manner of deposition of the parent material. The number, arrangement, and stage of development of these layers are largely the result of the common soil-forming processes, which have varied in intensity under the climatic conditions prevailing in the different localities. Their physical properties, such as color, structure, thickness, and relative position, depend upon the length of time the soil material has been exposed to weathering agencies and many other influencing factors such as topography, drainage, vegetation, and so forth. These layers are the means of dividing the soils into large groups, known as the soil series, which are further divided into soil types on the basis of variation in texture, that is, the proportion of sand, silt, and clay in the surface layers. The soils of each series have the same general profile in which the number, arrangement, and general character of the layers are the same. Reconnaissance soil surveys deal largely with the identification and isolation of the larger soil groups and less attention is given the soil type. On the soil map the types most prevalent in each series are shown as loams, sandy loams, and so forth, but each type may contain small tracts of heavier or lighter soils and in some cases small tracts of other soil series. Physiographic features, such as mountains, bad lands and bad-land basins, are shown separately and are not included in any of the soil series.

**TOPOGRAPHY.**—The chief physiographic and geographic features of the county are shown on the topographic map. The location and extent of geographic features, such as mountains, lakes, bad lands, and the more important stream courses, are represented on the map. The general relief of the land is divided into the following phases: (1) rolling land, (2) sharply rolling land or land too steep and broken for cultivation, (3) benches, (4) mountains, and (5) bad lands.

**AREA UNDER CULTIVATION:**—A record of the approximate acreage under cultivation was made at the time of this survey for the purpose of locating the more intensely cropped sections and if possible determining why these sections appear to be more favorably adapted to agriculture than others. The approximate percentage of each section in crop, fallow, and tame pasture is shown on the map. The Blackfeet Indian Reservation is largely utilized for the grazing of livestock and very little is under cultivation.

**LAND CLASSIFICATION:**—The Sixteenth Legislative Assembly of Montana provided for a classification of all lands in the state for taxation purposes. The manner of carrying out the provisions of the act was left to the county authorities. In 1916 the United States Geological Survey started a classification of the public lands in the western states for the purpose of designating those areas in which 640-acre tracts could be homesteaded under the Stock Raising Act. The state and government classifications were based largely upon the topographic and vegetative features and in no instance was any information obtained in regard to the soil relationships in any one county or between two or more counties.

The land classification map prepared by the United States Geological Survey does not cover all the land on the Blackfeet Indian Reservation. This map is of value in indicating the general adaptation of the land to agriculture. The utilization of the land is indicated on the map as follows: (1) farm lands, (2) farming grazing land, (3) grazing forage land, (4) grazing land, and (5) non-tillable grazing land. Other features, such as the location of the irrigated lands, are also shown.

#### DESCRIPTION OF SOILS

The regional profile of the soils of Glacier County varies largely with the elevation and location east of the mountains. The mature soils, classified according to color, belong to several soil groups: brown, dark-brown, black and gray. The brown and dark-brown soils cover the rolling plains and are characterized by rather dark-colored surface soils with well-developed carbonate zones below 8 to 40 inches. These soils have developed under a moderately low rainfall, a wide range in summer and winter temperatures, and a short grass cover. The black and gray soils cover the high plateaus and mountain slopes. These soils have developed under a greater rainfall, lower annual temperature, shorter growing season, and a tall grass and timber cover. In a few localities erosion is active and the soils show an immature development.

The mature soils developed over drift in Glacier County are grouped in four series: Joplin, Scobey, Williams, and Babb. The lighter-colored brown soils of the Joplin series, with carbonate zones 8 to 12 inches below the surface, occur at the lower elevations in the eastern part of the county. The darker-colored brown soils of the

Scobey series, with lime zones below 10 to 12 inches, cover the glaciated plains in the eastern half of the county. The dark-brown soils, with carbonate zones 15 to 40 inches below the surface, are included in the Williams series and occur in the south-central part of the county and in the basin along Willow Creek and the St. Mary's in the northern part. The soils of this series have developed over stony mountain drift and are darker and deeper than the Williams soils in northeastern Montana. These soils are shown on the soil map as a dark phase of the Williams series. The deep stony black soils of the Babb series are without carbonate zones in the surface 4 to 5 feet. These soils lie in the quaking aspen belt on the hummocky slopes of the mountains and grade into the gray timbered soils of the Glacier series at the higher elevations.

The Cheyenne series includes a group of brown soils developed on high terraces in the valleys of some of the larger streams, such as Badger Creek. The stony glacial outwash deposits are not included in the series, but are shown on the soil map as gravel deposits and swampy gravel deposits. In the central part of the county the preglacial valleys and basins are locally covered with gravelly drift of an outwash character. The soils developed over this material are included in the Scobey and Williams series, depending upon the color and depth of the lime zone.

The Cut Bank series includes a group of brown soils in the east-central part of the county, developed over outwash and glacial lake deposits containing a fair amount of coarse sedimentary material, such as sandstone fragments. These soils often grade into the soils of the Bainville series at the higher elevations.

The soils developed over calcareous shales and sandstones in various parts of the county are included in the Bainville and Morton series. The light-brown soils of the Bainville series are immature and below 3 to 5 inches often have the structure and stratification of the parent sandstones and shales. In the central part of the county the immature soils developed over red shales and sandstones have a distinct reddish color and are shown on the soil map as a red phase of the Bainville series. The dark-brown soils of the Morton series, with carbonate zones below 8 to 12 inches, are more mature. Red sandstone slabs characterize the surface of these soils in Glacier County. The soils of the Morton series occur above the sandstone escarpments on undulating benches in the northern part of the county. The more broken phases of this series in the western part are shown as a modified phase on the soil map, since the soils are often very shallow.

The soils developed over non-calcareous dark-colored shales are grouped in the Lismas and Pierre series. The Lismas series includes a group of immature heavy soils covering the shaly breaks of Two Medicine Creek, east of Glacier Park station. The soils of the Pierre series are immature olive-brown clays, with slightly calcareous surface

mulches, and usually have the platy structure of the parent shales below 1 to 3 feet. Tracts of these soils are distributed over the eastern half of the county at the lower elevations. In the uplands along Two Medicine Creek are several small tracts of mature soils developed over dark-colored shales. The soils of these tracts are shown as a deep phase of the Pierre series on the soil maps.

The Buffalo series includes a group of brown soils developed largely over colluvial material derived from the erosion of former quartzite gravel-capped benches in the central part of the county. The soils on top of the stony ridges often grade into the soils of the Croffs series and at the lower elevations into those of the Bainville and Morton series.

The soils on the high gravel-capped plateaus and benches are grouped in three series: Turner, Croffs, and St. Mary's. The stratified brown soils of the Turner series, with carbonate zones below 9 to 12 inches, cover the Seville bench west of Cut Bank. The dark-brown, almost black, soils of the Croffs series, with carbonate zones below 20 to 40 inches, occur on the high benches along the forks of Milk River. The deep stony black soils of the St. Mary's series, without carbonate zones in the surface 4 to 5 feet, occur on the St. Mary's and Milk River divides. The soils on the bench between Greasewood and Cut Bank creeks and in the basin along the North Fork of Milk River are shown as a phase of the Croffs series on the soil map. The timbered phase of the St. Mary's series is also shown on the map.

The Glacier series includes a group of gray timbered soils occurring on the higher slopes of the mountains. In the area surveyed the soils of this series are best developed on the slopes of Divide Mountains but also occur in various stages of development in the more densely timbered sections of the Babb series. The soils of this series are characterized by a gray ashy layer below the leaf mold.

The Orman series in Glacier County includes a group of mature brown soils found in the bottom of some of the ancient stream courses such as the gaps connecting the large streams. The soils of this series are usually underlain at depths of 3 to 5 inches by alkali mottled carbonate zones.

The soils developed over recent stream deposits are without distinct soil horizons and are grouped according to color into the Laurel and Choteau series. The Laurel series includes the stratified gray calcareous soils covering the bottom of streams in the central and eastern parts of the county. In this series are also included the bottoms of some of the mountain streams covered with river wash. In the central part of the county the bottoms of many of the upland streams are very alkaline and poorly drained and on the soil map are shown as an alkali phase of the Laurel series. The black stony non-calcareous and poorly drained soils in the bottom of the mountain streams, and also those heading on the high plateaus, are grouped

TABLE 3.—SOIL AND TOPOGRAPHY OF GLACIER COUNTY

Soils	Total area	Percentage of county		Level to sharply rolling	Sharply rolling
		Sq. mi.	P. ct.		
Joplin loams .....	44.0	1.4	43.7	0.3	
Joplin sandy loams .....	0.9	—	0.9	—	
Joplin silt loams .....	2.0	—	2.0	—	
Joplin silty clay loams .....	12.6	0.4	12.6	—	
Scobey loams .....	292.3	0.6	273.0	18.4	
Scobey sandy loams .....	14.6	0.4	14.6	—	
Scobey silt loams .....	13.6	3.4	13.6	—	
Scobey silty clay loams .....	12.0	0.4	12.0	—	
Scobey stony loams .....	122.0	4.0	54.8	67.8	
Scobey gravelly loams .....	147.4	4.8	146.3	1.1	
Williams loams—dark phase .....	95.4	3.1	87.0	8.4	
Williams stony loams .....	127.9	4.2	53.8	74.1	
Williams gravelly loams—dark phase...	11.7	0.3	11.7	—	
Cut Bank loams .....	25.7	0.6	25.7	—	
Cut Bank silt loams .....	47.2	1.5	47.2	—	
Cut Bank silty clay loams .....	10.2	0.3	10.2	—	
Cut Bank sandy loams .....	8.8	0.2	8.8	—	
Cut Bank gravelly loams .....	16.1	0.5	16.1	—	
Bainville loams .....	236.2	7.7	135.6	100.6	
Bainville loams—red phase .....	81.2	2.6	55.2	26.0	
Bainville silty clay loams .....	1.4	—	1.4	—	
Morton loams .....	8.1	0.2	8.1	—	
Morton loams—shallow phase .....	7.8	0.2	1.2	6.6	
Lisman clay loams .....	10.5	0.3	—	10.5	
Pierre clay loams .....	42.1	1.4	2.8	39.3	
Pierre clay loams—dark phase .....	8.8	0.3	8.8	—	
Turner sandy loams .....	52.3	1.7	52.3	—	
Turner gravelly loams—slopes phase ..	3.0	0.1	3.0	—	
Buffalo loams .....	78.4	2.5	78.4	—	
Buffalo stony loams .....	57.6	1.8	44.7	12.9	
Croffs loams .....	74.1	2.4	70.5	3.6	
Croffs stony loams .....	86.2	2.8	30.8	55.4	
Croffs stony loams—terrace phase .....	52.8	1.7	47.8	5.0	
St. Mary's stony loams .....	32.0	1.5	24.0	8.0	
St. Mary's sandy loams .....	4.7	0.1	4.7	—	
St. Mary's stony loams— timbered phase .....	35.1	1.1	25.1	10.0	
Glacier stony loams .....	24.2	0.6	3.6	20.3	
Eabb stony loams .....	131.0	4.3	58.6	171.4	
Babb loams .....	20.0	0.6	20.0	—	
Orman clay loams .....	2.3	—	2.3	—	
Cheyenne gravelly loams .....	7.3	0.2	7.3	—	
Phillips loams .....	3.1	0.1	3.1	—	
Chouteau loams .....	74.5	2.4	74.5	—	
Laurel loams .....	60.0	1.9	60.0	—	
Laurel loams—alkali phase .....	41.0	1.3	41.0	—	
Laurel clay loams .....	9.9	0.3	9.9	—	
Laurel clay loams—red phase .....	1.5	—	1.5	—	
Ead lands .....	6.7	0.2	—	6.7	
Mountains .....	753.3	24.7	—	753.3	
Stony outwash and gray terraces .....	4.2	0.1	4.2	—	
Swamps .....	17.0	0.5	—	—	
Lakes .....	11.8	0.3	—	—	

in the Choteau series. The scabby lake bottoms of the dry glacial lakes are included in the soils of the Phillips series.

The soils of Glacier County are grouped in nineteen soil series and forty-three soil types. Table 3 shows (1) the area in square miles of each soil type and physiographic feature, such as mountains and bad lands, and (2) the area unsuitable for agriculture because of its broken topography.

The land classification map prepared by the United States Geological Survey shows three classes of agricultural land in Glacier county: (1) grazing forage land, (2) grazing land, and (3) non-tillable grazing land. A large portion of Glacier County is adapted only to the grazing of livestock, but certain sections have greater agricultural possibilities than is indicated by the land classification map.

#### JOPLIN LOAMS

The surface 1 to 3 inches of the Joplin loams in Glacier County is a loose light grayish-brown silty to very fine sandy laminated mulch, which becomes slightly compact after heavy rains. The humus-bearing layer is a light chocolate brown friable columnar-structured loam ranging from 6 to 7 inches thick. The lower part of this layer is lighter in color, more compact, and slightly heavier in texture. The gray carbonate zone below 8 to 10 inches is a compact structureless silt loam grading into a yellowish loamy massive calcareous drift at 30 to 36 inches. Boulders are not very numerous on the surface and in the soil in the southeastern part of the county.

TOPOGRAPHY.—The Joplin loams in T. 32 N. have a "swell-and-saucer" type of topography, but east of Hay Lake they are more rolling and billowy. Low gravelly and stony hillocks and ridges and shallow lake depressions occur locally. Drainage has not been well established on the Joplin loams.

TILLABLE AREA.—The Joplin loams in Glacier County cover approximately 44 square miles of which less than one square mile is untillable. The area covered by these loams is classified as farming grazing land on the land classification map.

UTILIZATION.—The public range land east of the Blackfeet Indian Reservation was homesteaded in tracts of 160 and 320 acres and the tillable land was largely broken and placed in crops between 1910 and 1915. Dry-land farming was successfully carried on in this part of Montana up to 1917, when a severe drought set in; at its close in 1921, the cropped acreage was greatly reduced. In 1927 4 per cent of the tillable phase of the Joplin loams was under cultivation. The improved land was somewhat concentrated on the loams east of Hay Lake.

Exclusive grain farming was the most important type of agriculture on the Joplin loams up to the time of the drought. Stock raising has been growing in importance since that time and small herds are

often run in connection with the dry-land grain farms. Spring wheat and some flax are the most important cash crops grown on the loams. Other small grains, such as oats and barley, are grown chiefly for grain feed and forage. The climate is too cool to mature corn successfully and the yields of tame grass and legumes are rather low in average seasons.

Power machinery is used on the large grain farms consisting of one to three or more sections of land. The general practice in the area is to grow small grains continuously until the land becomes foul, when clean summer fallow is introduced every second or third year. Duckfoot cultivators and similar implements are generally employed in preparing the land for spring seeding and for summer fallowing. These implements are efficient in controlling weeds, retarding soil drifting by ridging the fields and leaving the stubble on the surface. Small combines have been employed the past few years in harvesting the large grain fields. Under the climatic conditions prevailing in this part of the state, stock raising combined with grain growing is probably more dependable than exclusive grain growing on the Joplin loams.

The Joplin loams have a fair water-holding capacity and are easily maintained in good tilth. The surface acre-foot contains from 3500 to 5000 pounds of nitrogen and from 1500 to 1800 pounds of phosphorus. The soils are well supplied with lime. The yields of spring grains, such as Marquis wheat, depend largely upon the amount and distribution of the seasonal rainfall. The average yield of spring wheat on well-prepared summer-fallowed land in normal seasons is between 10 and 15 bushels per acre, and in favorable seasons the yields often exceed 20 bushels per acre. Improved land is valued at \$10 and \$20 per acre, depending upon its location and improvements.

VEGETATION.\*—Grama grass (*Bouteloua gracilis*) and its associated species form the cover on the Joplin loams. The black-rooted sedge known as nigger wool (*Carex filifolia*) and slender wheat grass (*Agropyron tenerum*) are commonly associated with grama grass on the lighter-textured and more droughty loams. Other grasses, such as needle grass (*Stipa comata*) and June grass (*Koeleria cristata*) are more or less prevalent, especially in the overgrazed sections. Western wheat grass (*Agropyron smithii*) creeps in on the heavier

\*The vegetation is discussed from the standpoint of the economic value of the different species in their relationship to the livestock carrying capacity of the different soil types. The abundance and character of the vegetation is influenced by such adversities as drought, overgrazing, etc. The prevalence of such grasses and shrubs as needle grass, June grass, and mountain sage indicates adverse climatic conditions or poor range management. The carrying capacity of the range for running a steer through a grazing season (ten to twelve months) is an estimate made by experienced stockmen in the area for the different soil types. In determining the carrying capacity of the type for sheep, four to six ewes and their lambs are generally considered the equivalent of one steer.

loams. The tall grasses, such as slender wheat grass, become rather coarse upon maturity and are not as palatable as the short grasses.

Mountain sage (*Artemisia frigida*) is abundant on the Joplin loams. Gum weed (*Grindelia squarrosa*) and other shrubs are more or less common but have no economic value for forage. Prickly pear has a wide distribution and in some of the overgrazed sections forms dense patches.

In Glacier County the Joplin loams have a fair grass cover. The carrying capacity of these loams for livestock is between 30 and 35 acres per steer for a normal ten to twelve months grazing period. Mountain sage is a fair range forage for sheep and in some sections the range forage is better adapted to the grazing of sheep than cattle.

#### JOPLIN SANDY LOAMS

The surface 2 to 3 inches of the Joplin sandy loams is a loose light grayish-brown laminated fine sandy mulch. The humus-bearing layer is a friable slightly columnar-structured brown sandy loam 6 to 7 inches thick and underlain with a lighter brown, more compact, and faintly columnar-structured subsurface layer. The carbonate zone below 12 to 20 inches is a compact structureless grayish-brown gritty loam, grading into yellowish-brown calcareous sandy drift at 30 or more inches.

The Joplin sandy loams cover less than one square mile of rolling land above the breaks of Cut Bank Creek in the southeastern corner of the county. The more level phase of the tract is under cultivation. The surface acre-foot contains from 2700 to 4500 pounds of nitrogen and 1200 to 1500 pounds of phosphorus. The yields of spring wheat on the sandy loams compare favorably with those on the Joplin loams in normal seasons. The soils are likely to drift after the root fiber has been worked out. The more prominent grasses on the sandy loams are nigger wool, grama grass, and sand grass (*Calamovilfa longifolia*). Needle grass and June grass occur in the overgrazed areas. Mountain sage is usually not as conspicuous as on the loams. The carrying capacity of the sandy loams for livestock is about the same as that of the Joplin loams.

#### JOPLIN SILT LOAMS

The surface 2 to 3 inches of the Joplin silt loams is a loose granular light grayish-brown silty mulch. The humus-bearing layer is a compact slightly columnar-structured silt loam. The carbonate zone below 6 to 7 inches is a compact prismatic silt to silty clay loam, often streaked and blotched with lime. The parent drift below 24 to 30 inches consists of stratified lime-blotched olive-brown silts and silty clays.

The Joplin silt loams cover several shallow basins of less than 3 square miles in the southeastern part of the county. The land east of the reservation line was fairly well under cultivation. The

surface acre-foot contains from 3500 to 5000 pounds of nitrogen and from 1500 to 1900 pounds of phosphorus. The yields of small grain on well-prepared summer-fallowed land run slightly higher than on the Joplin loams. The silt loams are well covered with grama grass and western wheat grass. The carrying capacity of the silt loams for livestock is about the same as that of the Joplin loams.

#### JOPLIN SILTY CLAY LOAMS

The surface 2 to 3 inches of the Joplin silty clay loams is a loose granular light grayish-brown silty to silty clay mulch. The humus-bearing layer is a brown compact blocky-structured silty clay to clay loam, averaging about 4 inches thick and often effervescing weakly with acid in the lower part. The carbonate zone below 6 to 7 inches is a grayish-brown, prismatic silty clay, mottled and streaked with lime. The lower part of the zone below 20 inches is an olive-brown structureless silty clay and clay, usually flecked with lime and alkali. The parent drift below 24 to 30 inches is a calcareous olive-brown stratified silty clay. The surface mulch has a well-developed crust during the summer months and the clods of the carbonate zone have a glazed coating along seepage lines. Boulders are not very numerous on the surface, but some gravel occurs locally in the soil.

The Joplin silty clay loams cover a gently sloping area of 126 square miles above the breaks of Cut Bank Creek in the southeastern part of the county. These loams have not been broken on the reservation but in the basin east of the creek a small acreage has been placed under cultivation. On the land classification map these heavy loams are shown as non-tillable grazing land. The Joplin silty clay loams have a high water-holding capacity and should be summer fallowed a season before cropping for the accumulation of moisture in the subsoil and also for mellowing the clods. The surface acre-foot contains 3500 to 4500 pounds of nitrogen and 1500 to 1800 pounds of phosphorus. The yields of spring wheat in wet seasons are often exceptionally high but in dry seasons are often correspondingly low. The average yields run somewhat lower than on the Joplin silt loams. Grama grass and western wheat grass, with a sprinkling of prickly pear, form the chief cover on the heavy loams. The grass cover is not as dense as on the Joplin loams and a few more acres would be required to run a steer through a grazing season.

#### SCOBEY LOAMS

The Scobey loams, developed over drift of the continental ice sheet in the east-central part of the county, have a loose light grayish-brown laminated fine sandy mulch 1 to 2 inches thick on the surface. The humus-bearing layer is a friable columnar-structured brown loam of 4 to 6 inches thick. It overlies a shallow lighter brown more compact columnar-structured friable subsurface layer. The carbonate zone below 10 to 14 inches is a gray compact silt loam, grading into

yellowish-brown massive calcareous drift below 30 or more inches. The lower soil depths are locally stratified. Boulders are not as numerous on the surface and in the soil as on the darker-colored phase of the Scobey loams, but the content of gravel is somewhat greater.

The darker-colored phase of the Scobey loams in the north-eastern part of the county, also developed over drift of the continental ice sheet, has a loose dark-brown silty mulch on the surface. The mulch is 1 to 2 inches thick and contains numerous roots of a low creeping moss. The humus-bearing layer is a rich brown slightly compact columnar-structured granular loam 5 to 7 inches thick. It is underlain with a chocolate-brown more compact columnar-structured granular loamy subsurface layer. The gray to grayish-brown compact but rather friable silty carbonate zone lies 14 to 18 inches below the surface. Below 30 to 40 inches it grades into lime-blotched yellowish silt and silty clay loams. Boulders are quite numerous on the surface of the land and in the soil.

The Scobey loams, developed over mountain drift in the south-central part of the county, have rather dark-colored surface soils. The surface 1 to 2 inches is a loose silty to fine sandy laminated brown to dark-brown mulch, which often contains a large amount of root fiber derived from a creeping moss at the higher elevations. The humus-bearing layer is a brown to rich brown friable to granular columnar-structured loam 5 to 7 inches thick. The columnar-structured subsurface layer often has a yellowish or brassy brown color. The compact gray silty carbonate zone lies 9 to 18 inches below the surface and grades into lime-blotched dull brown massive drift at 30 to 40 inches. The soils developed over mountain drift are quite variable in texture and usually run high in stone on the hummocks and ridges and high in gravel on the slopes and in the basins. The parent drift often does not effervesce as freely with acid as the drift of the continental ice sheet.

**TOPOGRAPHY.**—The Scobey loams in the eastern and northeastern parts of the county have a hilly, morainic topography, grading into a billowy relief on the more gentle slopes. In the south-central part of the county the loams also have a hilly morainic topography, but locally the divides have a gentle relief. The tillable land is confined largely to the slopes and basins between the morainic ridges. Drainage has not developed in the upland sections.

**TILLABLE AREA.**—Scobey loams cover a total area of 296 square miles, of which 185 square miles is too hummocky for cultivation. Considerable waste land consisting of stony mounds, ridges, and pot-holes occurs in the area covered by the loams. On the land classification map the loams in the eastern part of the county are classified as grazing forage land and in other sections as non-tillable grazing land. The last-named includes the more hilly morainic phases of the type. This group contains a fair acreage of farm land distributed over the slopes of the morainic ridges and in the basins.

UTILIZATION.—Scobey loams are among the better agricultural soils in Glacier County. East of the reservation line the tillable phase was well under cultivation at the time of the survey. Spring wheat and flax are the most important cash crops. Other small grains and forage crops are grown on a small acreage. The average yield of spring wheat on well-prepared summer-fallowed land is between 15 and 25 bushels, but in favorable seasons the yields often exceed 30 bushels per acre. The temperature of the growing season probably averages lower on the darker-colored phases of the Scobey loams and in some seasons crops are likely to be damaged by fall frosts. Alternate crop and clean summer fallow is generally practiced by the best farmers. The waste lands on the loams can best be utilized for the grazing of livestock such as cattle, which can often be run in connection with the grain farms.

Scobey loams have a good water-holding capacity and are easily maintained in good tilth. The amount of nitrogen in the surface acre-foot for the lighter-colored phase ranges from 4200 to 6300 pounds and for the darker-colored phase from 6300 to 8300 pounds. The phosphorus content runs from 1750 to 2450 pounds, with an average of 2100 pounds in the surface acre-foot for both phases. The soils are well supplied with lime, although the surface soils of the darker-colored phase may show a deficiency in lime carbonate.

VEGETATION.—Grama grass and its associate species predominate on the Scobey loams. The density of the grass cover increases with the elevation and on the darker-colored phase it is somewhat heavier. The carrying capacity of the loams for livestock such as cattle is between 15 and 20 acres per mature animal. In the east-central part of the county on the lighter-colored phase, a few more acres would be required to run a steer through the grazing season. In normal seasons the range is usually covered with snow between December 15 and March 15.

#### SCOBEY SANDY LOAMS

The surface 1 to 2 inches of the Scobey sandy loams is a loose light-brown laminated sandy mulch. The humus-bearing layer is a weakly columnar-structured brown friable fine to coarse sandy loam 5 to 8 inches in thickness. The subsurface layer is a light-brown more compact sandy loam. The carbonate zone below 14 to 20 or more inches is a compact grayish-brown sandy loam. It grades into yellowish-brown structureless calcareous sandy drift at 36 inches or more. The sandy loams in the basin along Snake Creek contain small fragments of sandstone and the lower soil depths are often loose sands and gravels. Coarse sandy loams predominate on most of the tracts.

Scobey sandy loams cover outwash slopes above Snake Creek in the eastern part of the county, and also occur as isolated tracts along the South Fork of Milk River in the north-central part and

in other sections of the county. The loams cover an area of 14.6 square miles and have a topography suitable for cultivation. On the land classification map the sandy loams are classified as grazing forage land and as non-tillable grazing land. The soils are in general too sandy for farming and the land can best be utilized for grazing of livestock. The surface acre-foot contains a somewhat lower amount of nitrogen than the Scobey loams, and the phosphorus and lime contents are usually lower and more variable. The sandy loams have a fair cover of grama grass and nigger wool. The carrying capacity of these sandy loams for livestock is between 25 and 30 acres per animal.

#### SCOBEY SILT LOAMS

The Scobey silt loams in the basin along Red Creek in the north-eastern corner of the county have a loose granular grayish-brown laminated silty mulch on the surface. The mulch averages  $1\frac{1}{2}$  inches thick and during the summer months has a shallow friable crust. The humus-bearing layer is a brown compact granular slightly columnar-structured silt loam 4 to 5 inches in thickness. The carbonate zone below 6 inches is a compact prismatic grayish-brown silt loam grading at 15 inches or more into a lime-blotched buff or yellowish-brown massive structureless silty clay loam. A small amount of gravel occurs in the soils but boulders are not numerous on the surface. The Scobey silt loams in the lake basins, such as Hay Lake, often have a grayish cast due to poor drainage.

Scobey silt loams cover the gentle slopes of the basin along Red and Snake creeks and also around several glacial lakes in the north-eastern part of the county. The silt loams cover a total area of 13.6 square miles and are classified as grazing forage land on the land classification map. The loams are well under cultivation in the basin along Red and Snake creeks and the better-drained phases in the glacial lake basins. The cropped acreage was devoted largely to spring wheat. The yields of spring wheat reported on the silt loams were as good as on the Scobey loams. The amount of nitrogen and phosphorus in the surface acre-foot compares favorably with the amounts of these elements found in the darker-colored phase of the Scobey loams. The chief cover on the silt loams is western wheat grass. The carrying capacity of these loams for livestock is around 20 acres per animal.

#### SCOBEY SILTY CLAY LOAMS

The Scobey silty clay loams in the basin along Red Creek have a loose grayish-brown granular laminated mulch on the surface. The crusted mulch is  $1\frac{1}{2}$  inches thick and the lower quarter of an inch has a distinct platy structure. The shallow non-calcareous humus-bearing layer is a brown cloddy silty clay loam 2 or 3 inches in thickness. The carbonate zone below 3 to 4 inches is a compact lime-blotched silty clay grading into a lime-streaked alkali-flecked massive

structureless dull olive-brown silty clay at 18 inches or more. The irregular clods along seepage lines have a glazed coating in the lower soil depths. The more eroded and also the poorly drained phases of the silty clay loams often effervesce with acid at the surface.

The Scobey silty clay loams occupy the lower part of the basins along Red Creek in the northeastern part of the county and along Snake Creek north of Cut Bank. These heavy loams cover 12 square miles, which are classified as non-tillable grazing land on the land classification map. The soils are heavy and retractive and only a limited area is under cultivation. They have approximately the same amount of nitrogen and phosphorus in the surface acre-foot as the Scobey silt loams. The land has a fair cover of western wheat grass, and the more poorly drained phases can best be utilized for the grazing of livestock. The carrying capacity of the silty clay loams for livestock is between 20 and 25 acres per head.

#### SCOBEY STONY LOAMS

Scobey stony loams include a group of stony soils ranging in texture from stony loam to stony sandy and gravelly loams. The profiles of the stony loams are in general the same as for the different phases of the Scobey loams found in the vicinity of the stony tracts. The soils on the tops of the stony mounds and ridges are often shallow, but on the northern slopes of the mounds and in the depressions they are usually deep dark-colored stony loams. The stony loams developed over mountain drift are more stony and gravelly than those developed over the bouldery drift of the continental ice sheet. The Scobey stony loams grade into the Scobey gravelly loams in the basins between the morainic ridges and also on the outwash slopes. In the south-central part of the county the Scobey stony loams grade into the Williams stony loams without any change in the topography of the land.

The Scobey stony loams cover morainic sections in the eastern and south-central parts of the county. The moraines are characterized by high stony mounds and ridges and deep pot-holes and depressions. The stony loams cover a total area of 123 square miles of which 55 square miles has a topography suitable for cultivation. On the land classification map the stony loams are classified as non-tillable grazing land. These loams have approximately the same amount of nitrogen, phosphorus, and lime in the surface acre-foot as the Scobey loams. The land is too stony for farming and can only be utilized for the grazing of livestock. Grama grass forms the chief cover. The carrying capacity of the Scobey stony loams for livestock is about the same as that of the Scobey loams.

#### SCOBEY GRAVELLY LOAMS

The Scobey gravelly loams in the uplands north of Cut Bank Creek in the east-central part of the county have a grayish-brown,

gravelly sandy mulch on the surface, averaging about  $1\frac{1}{2}$  inches thick. The humus-bearing layer is a brown columnar-structured friable gravelly loam of 5 to 7 inches in thickness. The gravelly subsurface layer is a chocolate-brown columnar structured loam. The carbonate zone below 10 to 12 inches is a compact calcareous gray gravelly silt loam, grading locally into yellowish-brown stratified loose sand and gravel at 29 inches or more.

The surface 3 inches of the Scobey gravelly loams developed over gravelly outwash northwest of Bombay is a loose grayish-brown sandy mulch. The humus-bearing layer is a brown friable sandy gravelly loam. Below 10 inches the gray carbonate zone is a sandy gravelly loam grading into stratified yellowish brown sand and gravel at 30 inches or more. The gravelly loams in the preglacial valley of Cut Bank Creek and in the basins between the morainic ridges in the central part of the county are gravelly loams and gravelly sandy loams with lime horizons below 10 to 15 inches. In the preglacial valley the soils of the poorly drained phases are often very dark colored.

In the north-central part of the county along the South Fork of Milk River the lower slopes of the high benches and uplands are covered with stratified gravelly soils which are grouped with the Scobey gravelly loams. The gravels are of glacial and colluvial origin. The soils on the sloping benches have well-developed surface mulches and the gravelly columnar-structured humus-bearing layer has a rich brown color. The carbonate zone lies 10 to 17 inches below the surface and grades into stratified sands and gravels with depth.

Scobey gravelly loams cover gravelly basins between morainic ridges and the bottom of the preglacial valley of Cut Bank Creek in the central part of the county. These loams also cover sloping benches above Cut Bank Creek in the eastern part and along the South Fork of Milk River in the northern part. The basins and bottom of the preglacial valley are often poorly drained. The gravelly loams cover a total area of 148 square miles of which 1 square mile is too broken for cultivation. On the land classification map the gravelly loams are classified as non-tillable grazing lands. The surface acre-foot contains from 4000 to 6000 pounds of nitrogen and from 1750 to 2100 pounds of phosphorus. Tracts of land suitable for farming occur on the gravelly benches above Cut Bank and the South Fork of Milk River but the gravelly loams in other sections of the county are too droughty for farming unless water is available for irrigation. The land has a fair cover of grama grass and has a carrying capacity for livestock of 20 to 25 acres per head of cattle.

#### WILLIAMS LOAMS—DARK PHASE

The surface  $2\frac{1}{2}$  inches of the Williams loams—dark phase in the basins along St. Mary's River and Willow Creek in the north-central part of the county is a dark-brown, almost black, friable loamy mulch,

containing a large amount of organic matter. The humus-bearing layer is a rich dark brown friable granular blocky-structured loam, which has a horizontal cleavage and averages 7 to 9 inches thick. The subsurface layer is brown compact but friable granular loam. The carbonate zone below 30 to 40 inches is a grayish-brown lime-blotched silt loam extending below a depth of 5 feet. Boulders are quite numerous on the surface and in the soils of the basin along Willow Creek and stony and gravelly in the soils of the basin above St. Mary's River.

The soils developed over mountain drift north of Two Medicine Creek in the south-central part of the county have profiles resembling those found on the Williams loams in the northeastern part of the state. The surface 2 inches of these soils is a very dark brown friable loamy mulch, containing a large amount of organic matter. The humus-bearing layer is a dark-brown columnar-structured friable loam about 7 inches in thickness. The subsurface layer is a brown fairly compact columnar-structured loam. The zone of lime accumulation below 17 to 22 inches or more is a grayish-brown compact silt loam, grading into structureless yellowish-brown lime-blotched drift at 40 inches or more. The soils are quite stony and gravelly.

The dark phase of the Williams loams covers the basin along St. Mary's River and Willow Creek, and the lighter-colored phase the rolling billowy divide north of Two Medicine Creek. The land in the basin of Willow Creek is hummocky and a number of freshwater lakes occur in the area. Drainage has not developed on the Williams loams. The loams cover a total area of 95 square miles, of which 8 square miles are too hummocky for cultivation. A portion of the area covered by these loams on the divide north of Two Medicine Creek is included in the non-tillable grazing land on the land classification map. The surface acre-foot of the darker-colored phase contains from 9000 to 12,5000 pounds of nitrogen and of the lighter-colored phase from 7000 to 9000 pounds. The soils contain an average of 2100 pounds of phosphorus. The surface acre-foot of both phases is low in lime carbonate, but has about 10,000 pounds of calcium. The Williams loams lie at an elevation above 4500 feet, which is probably above the limit of general farming in this part of the state. The growing season at this elevation is cool and short and only the early maturing crops, such as oats and barley, can be successfully matured in normal seasons. Longer maturing crops, such as spring wheat, can probably be grown locally, where the air drainage is good. Most of the crops produced on the Williams loams in Glacier County will be grown for feed and forage to supplement the summer grazing lands. The tall grasses predominate in the basin along St. Mary's river and Willow Creek. Buck brush and other shrubs occur on the slopes of the low mounds and ridges where the snow accumulates during the winter months. The stand of grass is dense and less than 10 acres would be required to run a steer through a grazing season. The

Williams loams are covered with snow for three to four months in the year.

#### WILLIAMS STONY LOAMS—DARK PHASE

The profiles of the Williams stony loams are much the same as described for the different phases of the Williams loams. In the southern part of the county the color and structure of the soil gradually change with the elevation. The carbonate zone varies from 17 inches below the surface in the eastern part to 30 to 40 inches in the western part and in the basin of Willow Creek. The soils developed over mountain drift are very stony and gravelly.

Williams stony loams cover high stony moranic sections in the southern part of the county and in the basin along Willow Creek. The terminal and recessional ridges and mounds are very stony. The stony loams cover a total area of 128 square miles of which 74 square miles are sharply rolling ridges and mounds. A portion of the area covered by the stony loams is classified as non-tillable grazing land on the land classification map. The amount of nitrogen, phosphorus, and lime in the surface acre-foot does not differ greatly from the amounts found in the different phases of the Williams loams. The land covered by the stony loams can be utilized only for grazing. The stony loams have the same grass cover and carrying capacity as the Williams loams. Tall shrubs such as buck brush are more abundant on the slopes of the mounds and ridges.

#### WILLIAMS GRAVELLY LOAMS—DARK PHASE

The surface 2 inches of the Williams gravelly loams is a dark-brown loamy mulch, containing a large amount of organic matter. The humus-bearing layer is a dark-brown friable columnar-structured gravelly loam 5 to 7 inches thick. The brown slightly columnar-structured subsurface layer is very gravelly. The gray gravelly zone of lime accumulation lies 10 to 20 or more inches below the surface and grades into loose gravels with depth. The gravels consist largely of limestone and other sedimentary rock fragments.

The Williams gravelly loams cover an undulating upland section in the southern part of the county with an area of 12 square miles, which is shown on the land classification map as non-tillable grazing land. The surface acre-foot contains from 8000 to 9000 pounds of nitrogen and 2100 pounds of phosphorus. The gravelly loams lie above 4500 feet and are probably too high for the production of feed and forage crops. The gravelly loams can best be utilized for the grazing of livestock. The land is well covered with grass, consisting largely of the tall bunch grasses. Its carrying capacity for livestock is between 10 and 15 acres per head of cattle.

#### CUT BANK LOAMS

The Cut Bank loams have a loose shallow light-brown sandy mulch on the surface. The humus-bearing layer is a brown, slightly

columnar-structured loam 4 to 6 inches in thickness. The carbonate zone below 6 to 9 inches is a grayish-brown compact loam, overlying rather firm sandstones at 3 to 5 feet or more. Fragments of sandstone and some gravel occur in all sections above the sandstone. Below the escarpment in T. 35 N., R. 5 W., slabs of sandstone occur on the surface and in the soil and also outcrop locally.

Cut Bank loams have an undulating topography below the sandstone escarpment and along Little Rocky Coulee. The loams cover 27 square miles and are classified as grazing forage land on the land classification map. The surface acre-foot contains 4000 to 5000 pounds of nitrogen and 2100 pounds of phosphorus. The loams outside of the Indian reservation were well under cultivation at the time of the survey. Spring wheat, grown locally on summer-fallowed land, was the most important crop. The yields of spring wheat compare favorably with those on the lighter-colored phase of the Scobey loams. Grama grass forms the chief cover on the loams. The carrying capacity of the Cut Bank loams for livestock is between 20 and 25 acres per animal.

#### CUT BANK SILT LOAMS

The surface one-eighth inch of the Cut Bank silt loams is a gray compact silty crust, overlying a light grayish-brown loose granular silty mulch 1 inch in thickness. The humus-bearing layer is a chocolate-brown silt loam. Below 6 inches the gray carbonate zone is a compact silty loam grading at 15 inches into a light-brown compact calcareous silty material and at 33 inches more into more friable fine sandy and silty floury material.

The Cut Bank silt loams also have an undulating topography. The silt loams cover 35 square miles which are shown on the land classification map as grazing land. The soils run slightly higher in nitrogen and phosphorus in the surface acre-foot than the Cut Bank loams. A fair acreage devoted to spring wheat was broken on the silt loam tracts east of the reservation. The surface soils have a greater water-holding capacity than the loams, but the subsoils are somewhat more droughty and in unfavorable seasons the yields of spring wheat are likely to be below those on the loams. Western wheat grass and grama grass form the chief cover on the silt loams. The carrying capacity of the Cut Bank Silt loams is between 20 and 25 acres per mature steer.

#### CUT BANK SILTY CLAY LOAMS

The Cut Bank silty clay loams have a shallow light grayish-brown granular crusted surface mulch, which often effervesces freely with acid. The compact calcareous light-brown to light-olive-brown silty clays are quite uniform to a depth of 40 inches or more, except for a cloddy layer at the surface and an alkali-flecked zone below 15 to 18 inches. The glacial lake deposit is of considerable depth and overlies sandstones.

Cut Bank silty clay loams cover an undulating tract between Little Rocky Coulee and Rock Coulee and a small basin east of Rock Creek. The heavy soils cover an area of 10 square miles which are shown on the land classification map as untillable grazing land. The soils are heavy and retractive and are best adapted to the grazing of livestock. Western wheat grass predominates on the heavy loams. The carrying capacity of the silty clay loams for livestock is somewhat lower than that of the Cut Bank silt loams.

#### CUT BANK SANDY LOAMS

The Cut Bank sandy loams southwest of Headlight Butte have a shallow light-colored sandy mulch on the surface. The humus-bearing layer is a light-brown calcareous sandy loam 4 to 5 inches in thickness. It grades into a grayish-brown compact sandy loam, overlying sandstone at depths of 5 feet or more. Fragments of sandstone and gravel occur in the soils. Sandstones outcrop on the hills, and sandstone slabs often cover the more eroded slopes. The tract east of Rock Coulee is covered with a coarse sandy loam, with lime horizons below 12 to 15 inches.

The Cut Bank sandy loams cover rolling tracts along Rock Coulee, an area of 9 square miles, which are shown as non-tillable grazing land on the land classification map. The soils contain a lower amount of nitrogen but have about the same amount of phosphorus as the Cut Bank loams. The sandy loams on the tract southwest of Headlight Butte are among the marginal agricultural soils in the county, but the tract farther south is probably too droughty for farming and can best be utilized for grazing. Grama grass forms the chief cover on the sandy loams. The carrying capacity of the Cut Bank sandy loams for livestock is between 25 and 30 acres per animal.

#### CUT BANK GRAVELLY LOAMS

The surface 2 inches of the Cut Bank gravelly loams is a light grayish-brown gravelly sandy mulch. The humus-bearing layer is a slightly columnar-structured brown friable gravelly loam, grading into a sandy loam along Rock Coulee. The gray gravelly loamy carbonate zone lies 7 to 10 inches below the surface and grades into stratified material consisting largely of sand and gravel with depth. The soils also contain fragments of sandstone.

The Cut Bank gravelly loams cover undulating tracts which are characterized by low gravelly hummocks 2 to 3 feet high west of Rock Coulee. The gravelly loams cover 16 square miles, all of which is shown as nontillable grazing land on the land classification map. The surface acre-foot contains approximately the same amount of nitrogen and phosphorus as the Cut Bank loams. The gravelly loams are classified as non-tillable grazing land but locally the less hummocky and gravelly phases may be included among the marginal

farm lands in the county. Grama grass forms the chief cover on the gravelly loams. The stand is good, and the carrying capacity of the land for livestock is between 20 and 25 acres per steer.

#### BAINVILLE LOAMS

The more level phases of the Bainville loams developed over calcareous sandstone have a loose shallow light grayish-brown sandy mulch on the surface. The humus-bearing layer is a light-brown to brown friable sandy loam to loam ranging from 3 to 5 inches thick. Below 5 to 7 inches the lower soil depths are calcareous rusty-streaked sands and loams having the structure and stratification of the parent material and grading into decomposed sandstones at 3 to 5 feet or more. Slabs of sandstones often occur on the surface and fragments of sandstones in the soil. The color of the surface soils depends upon the elevation and location. In the west-central part of the county they grade into the shallow phase of the Morton loams. The more broken phases of the Bainville loams usually have a calcareous mulch on the surface, and the sandstones are often exposed.

The Bainville loams in Glacier County include tracts of heavy soils developed over calcareous shales. These soils are usually calcareous at the surface and contain more or less alkali. The profiles of these heavy soils are not as well developed as those of the Bainville loams and sandy loams.

The Bainville loams are distributed in small tracts over the central and eastern parts of the county. They cover a total area of 236.2 square miles of which 100.6 square miles are too broken for cultivation. On the land classification map the loams are classified as non-tillable grazing land. The surface acre-foot contains from 3500 to 5000 pounds of nitrogen and approximately 2100 pounds of phosphorus. The more level phases are among the marginal agricultural lands in the county, but the sharply rolling phases can be utilized only for the grazing of livestock. The grass cover consists chiefly of grama grass and the land has a carrying capacity for livestock of 20 to 25 acres per steer.

#### BAINVILLE LOAMS—RED PHASE

The red phase of the Bainville loams developed over red shales and sandstones has profiles similar to those of the Bainville loams except for color. The surface soils are predominantly silty clay loams, with reddish-brown shallow granular mulches and pinkish-brown zones of lime accumulations below 4 to 6 inches. The lower soil depths have the structure and stratification of the parent material and grade into decomposed red shales at 3 to 5 feet or more. The more eroded phases effervesce freely with acid at the surface or within the surface 2 or 3 inches. The bottoms of the coulees and basins are highly impregnated with alkali. On some of the tracts the surface soils are modified by wash gravel from the high benches.

The red phase of the Bainville loams covers a high rolling to broken area in the central part of the county and also occurs locally on the lower eroded slopes of the gravel-capped benches in this part of the county. The red loams cover a total area of 81 square miles of which 26 square miles are too broken for cultivation. On the land classification map the loams are classified as non-tillable grazing land. These loams lie at an elevation above 4300 feet and contain a somewhat higher amount of nitrogen in the surface acre-foot than the Bainville loams but have approximately the same amount of phosphorus. The heavy phases cover chiefly grazing land. The grass cover on many of the tracts is not as heavy and is more patchy than on the Bainville loams, and a few more acres would be required to run a steer through a grazing season.

#### BAINVILLE SILTY CLAY LOAMS

The Bainville silty clay loams developed over calcareous shales usually have a crusted calcareous silty clay mulch on the surface. The dull grayish-brown humus-bearing layer is rather shallow and poorly defined. The silt to silty clay subsoils are highly impregnated with alkali and often have the stratification of parent shales in the lower depths.

The Bainville silty clay loams cover about 1.5 square miles of rolling land in the southeastern part of the county. On the land classification map the area covered by these loams is classified as non-tillable grazing land. The soils are in general too poorly drained, too high in alkali, and too retractive for dry-land farming and the land is used chiefly for the grazing of livestock. A light patchy stand of grama forms the chief cover. These heavy clay loams have a lower carrying capacity for livestock than the Bainville loams.

#### MORTON LOAMS

The Morton loams in the east-central part of the county have a loose brown shallow sandy mulch on the surface. The humus-bearing layer is a rich brown friable columnar-structured loam 7 to 8 inches in thickness. The gray carbonate zone below 9 to 10 inches is a compact but friable loam overlying gray sandstones interstratified with shales at various depths. Slabs of red and gray sandstones occur on the surface and in the soil. The Morton loams on the tract in the north-central part of the county have the texture of a coarse sandy loam, with carbonate zones 1 to 2 inches closer to the surface. Sandstones underlie the surface of the tract at depths of 2 to 3 feet. Sandstone slabs also occur on the surface.

The Morton loams cover rather level sandstone benches in the eastern and north-central parts of the county. The dark-colored loams cover 8 square miles. On the land classification map the tract outside of the Indian reservation is classified as grazing land. The surface acre-foot contains approximately the same amount of nitrogen

as the Scobey loams, but the chemical analyses available indicate that the soils run slightly higher in phosphorus. The deeper phases of the Morton loams are among the agricultural soils in Glacier County. The tract east of the reservation was well under cultivation at the time of the survey, and the yields of spring wheat reported on the loams compared favorably with those on the Scobey loams. The more sandy and shallow phases are probably too droughty for farming. The benches are well covered with grama grass and have a high carrying capacity for livestock.

#### MORTON LOAMS—SHALLOW PHASE

The Morton loams in the western half of the county cover an area of 7.8 square miles consisting of sandstone outcrops and buttes. The soils are deep dark-colored loams and sandy loams on the lower slopes but are rather shallow on the tops of the hills and breaks. On the soil map these loams are shown as a shallow phase of the Morton loams. The slopes of the outcrops and buttes have a good grass cover and a fair carrying capacity for livestock.

#### LISMAS CLAY LOAMS

The Lismas clay loams have a crusted non-calcareous dark-brown granular silty clay mulch on the surface. Below the mulch the soils are cloddy structureless non-calcareous olive-brown silty clays and clays, grading into dark-colored decomposed shales at 1 to 3 feet or more.

The Lismas clay loams cover the shaly breaks of Two Medicine Creek, east of Glacier Park station. The heavy loams cover an area of 10 square miles. The land is quite barren except for a few scrub pines in the coulees.

#### PIERRE CLAY LOAMS

The surface 1 to 2 inches of the Pierre clay loams is a crusted granular slightly calcareous grayish-brown silty clay mulch. It is underlain with a rusty-colored olive-brown cloddy plastic silty clay, which usually grades into a non-calcareous massive structureless olive-brown silty clay and clays often flecked with alkali and mottled with rusty-brown silty spots below 15 to 18 inches. The platy structure of the parent shales occurs in the soils at depths of 3 to 5 feet. In the northern and eastern parts of the county, the heavy alkali soils on the slopes of some of the basins are included in the Pierre clay loams. The surface and subsoils of these structureless silty clays often effervesce freely with acid.

The Pierre clay loams are distributed over the eastern half of the county. The isolated tracts cover a total area of 42 square miles of which 3 square miles are too broken for cultivation. On the land classification map the land is classified as non-tillable grazing land. The soils contain a fair amount of nitrogen and run somewhat higher

in phosphorus than those developed over drift. The land is too heavy and alkaline for farming and is utilized for the grazing of livestock. The heavy clays are lightly covered with vegetation and are among the poorest grazing lands in the county.

#### PIERRE CLAY LOAMS—DEEP PHASE

The deep phase of the Pierre clay loams has a non-calcareous dark-brown granular mulch on the surface. The surface soils are dark-brown cloddy non-calcareous silty clays, grading into a prismatic olive-brown silty clay at 8 to 10 inches. Below 15 to 18 inches the zone of lime accumulation is a lime-blotched structureless silty clay extending below 5 feet.

The deep phase of the Pierre clay loams covers several gently sloping upland tracts along Two Medicine Creek, east of Glacier Park station. This phase covers 9 square miles and lies outside the area surveyed by the United States Geological Survey land classifiers. The soils are well supplied with nitrogen and phosphorus but lie at too high an elevation for small grain farming, except possibly for feed crops. The land has a good grass cover and a high carrying capacity for livestock.

#### TURNER SANDY LOAMS

The Turner sandy loams have a shallow light grayish-brown loose sandy surface mulch. The humus-bearing layer is a friable slightly columnar-structured sandy loam 5 to 6 inches in thickness. The shallow light-brown subsurface layer is often very gravelly. The grayish-brown compact sandy and gravelly carbonate zone lies 9 to 10 inches below the surface and grades into stratified sands and gravels at 3 to 5 feet or more. The surface soils contain more or less rounded quartzite gravel, which is usually more conspicuous in the subsurface layer, above the well-developed lime carbonate zone. On the soil map the soils are shown as sandy loams, but vary in texture from sandy loams to loams and gravelly loams and in the western part of the Seville bench are several shades darker in color. The surface soils above the breaks of the bench are shallow and gravelly.

South of the Seville bench lies a lower bench along Spring Creek. The soils on this bench are more stony, darker colored, and deeper horizoned. The soils of this bench are grouped with the Turner Sandy loams.

The Turner sandy loams cover the Seville bench west of Cut Bank and a lower stony bench along Spring Creek. The Seville bench slopes gently to the east and in the western part is characterized by low gravelly bars rising 1 to 2 feet above the general level. The gravel deposit capping the bench is 10 to 20 feet or more thick, and the sags are often poorly drained. The sandy loams cover 55 square miles, which are shown on the land classification map as

grazing forage land and grazing land. The surface acre-foot contains from 4000 to 7200 pounds of nitrogen and from 1750 to 2350 pounds of phosphorus. Parts of the bench are probably too shallow and gravelly for growing small grain crops above the ditch, but under irrigation should produce fair yields of these crops and also forage crops. At the time of the survey the eastern half of the bench was under irrigation and a fair acreage devoted chiefly to spring wheat and alfalfa. The wheat grown under irrigation on the sandy loams had a yellowish color during the rather cool growing season in 1927, indicating a deficiency of available nitrogen. The average yields of spring wheat reported were below those on the Seobey loams. Proper rotation of the small grains with leguminous crops may result in higher average yields of the small grains. The Turner sandy loams have a fair grass cover of grama grass and their carrying capacity for livestock is between 20 and 25 acres per steer.

#### TURNER GRAVELLY LOAMS—SLOPE PHASE

The breaks of the Seville bench are very gravelly and the land below them for several miles is covered with more or less wash gravel. East of the bench the gravels are underlain with sandstone and south of the bench with shales at various depths. The tillable land on the rolling tract east of the bench grades into a gravelly phase of the Bainville loams and south of the bench into the Pierre clay loam. The tracts lie below the irrigation canals on the bench but the heavy clays are too alkaline and poorly drained for farming. A portion of the tract east of the bench can be placed under cultivation. The Turner gravelly loams cover 3 square miles and are shown on the land classification map as non-tillable grazing land. The land east of the bench has a fair covering of grama grass and a carrying capacity slightly lower than that on the bench, but the heavy loams south of the bench are poorly grassed over and have a much lower carrying capacity for livestock.

#### BUFFALO LOAMS

The darker-colored phase of the Buffalo loams at the higher elevations has a loose brown sandy mulch on the surface. The humus-bearing layer is a dark brown rather granular columnar-structured loam 5 to 7 inches in thickness. The subsurface layer is a rich brown, more compact and heavier-textured loam. The grayish-brown compact but friable silty clay carbonate zone lies 13 to 19 inches below the surface and grades into lime-mottled structureless olive-brown silty clay material at 32 inches or more. Below 46 inches the silty clays are usually less mottled with lime.

The lighter-colored phase of the Buffalo loams such as is found at the lower elevations around Horsethief Butte, has a lighter-colored sandy mulch on the surface. The brown columnar-structured friable loamy humus-bearing layer is 4 to 6 inches thick and grades into a

shallow lighter-brown subsurface layer. The grayish-brown compact silty carbonate zone lies 9 to 15 inches below the surface and often grades into residual material derived from sandstones and shale found at depths of 3 feet or more.

The amount of stone and gravel on the surface and in the soils is quite variable. It usually increases with the elevation and is more abundant on the tops of the hills and ridges. Shales and sandstones often outcrop in the more eroded sections and locally the coulees and basins are highly impregnated with alkali. The darker-colored soils are found on the northern and western slopes of the hills and ridges where the snow accumulates during the winter months.

The Buffalo loams cover a rather sharply rolling area in the central part of the county, which is characterized by gravel-capped hills and ridges and more or less colluvial gravel and stone on the surface of the land. The Buffalo loams cover 78 square miles, which are shown on the land classification map as non-tillable grazing land. The surface acre-foot contains from 5,000 to 6,000 pounds of nitrogen and from 2,100 to 2,400 pounds of phosphorus. The loams lie above 4,300 feet in elevation, which limits the number and variety of crops successfully matured. At elevations of 4,300 to 4,400 feet spring wheat can possibly be matured in normal seasons on the less rolling and stony phases. The soils are well covered with vegetation. At the lower elevations grama grass is the chief cover. The carrying capacity for livestock is between 15 and 20 acres per animal.

#### BUFFALO STONY LOAMS

The surface 2 inches of the Buffalo stony loams is a dark-colored loose sandy mulch, containing a large amount of root fiber. The humus-bearing layer is a dark-brown friable columnar-structured loam 4 to 6 inches thick. The columnar-structured subsurface layer is a light-brown loam. The gray compact lime zone lies below 11 to 19 inches and grades into stony yellowish-brown silty material at 30 inches or more. The lime is heavily concentrated on the upper 3 or 4 inches of the carbonate zone. All sections contain quartzite rock and gravel.

Buffalo stony loams cover gravel-capped hills and ridges in the central part of the county. On some of the ridges the quartzite rocks are 1 foot in diameter. The stony loams cover a total area of 57 square miles, of which 13 square miles is too broken for cultivation. On the land classification map the land is classified as non-tillable grazing lands. The surface acre-foot contains more nitrogen but approximately the same amount of phosphorus as the Buffalo loams. The land is too stony for cultivation and can be utilized only for grazing of livestock. The tall grasses predominate on the stony loams, which have a carrying capacity for livestock of 12 to 15 acres per head of cattle.

## CROFFS LOAMS

The soils on the high benches in the central and north-central parts of the county are grouped under the Croffs loams. The surface of the high benches is very stony, but more stone occurs on the surface than in the soils. The soil profiles on the different benches vary somewhat and a brief description of the soils of the larger benches is given.

The surface  $2\frac{1}{2}$  inches of the Croffs loams on the high bench north of the South Fork of Milk River is a dark-brown, almost black, gritty loam, containing a large amount of organic matter. The humus-bearing layer is a blocky dark-brown slightly granular loam, with a horizontal cleavage. It is 6 to 8 inches thick and grades into a slightly columnar-structured brown compact loam with a few lime concretions distributed through the section. Below 15 to 18 inches the upper part of the gray compact carbonate zone is a concretionary silt loam having locally a pinkish color. The concretions consist of soft pellet-like silty calcareous material. Below 30 inches or more the lower soil depths are lime-blotched gravelly silty clays but locally grade into pinkish calcareous structureless silty clays, derived from the underlying red shales. All sections contain more or less gravel and quartzite rock. The borders of the benches are usually very stony.

The soils of the high gravel-capped bench south of the South Fork of Milk River have black loamy organic mulches about 3 inches thick on the surface. The humus-bearing layer is a dark-brown blocky-structured loam 6 to 8 inches in thickness. The subsurface is a more compact slightly columnar-structured loam. The carbonate zone below 18 to 21 inches is a lime-streaked silt loam, with a few soft pellet-like, silty concretions distributed through the upper part. Below 44 inches or more the light or olive-brown silty clay is banded and streaked with grayish-brown silty material. Some gravel and rock occur in all sections.

The surface 3 inches of the outwash phase of the Croffs loams in the basin above the North Fork of Milk River is a black loose organic mulch. The humus-bearing layer is a slightly compact granular loam 8 inches thick. It grades into a more compact loamy subsurface layer. Below 25 inches or more the light-brown silty carbonate zone is streaked with lime and at 60 inches or more it grades into grayish-brown calcareous stratified silts and silty clays. The soils contain more or less stone and gravel in all layers. Below the Canadian line the soils above the stream are locally loose gravels and sands. Below the slope of the high bench on the east the soils are locally modified by red residual material, which underlies the outwash deposit at various depths.

The Croffs loams on the bench between Greasewood and Cut Bank Creeks have a slightly different profile than is found on the

high benches and in the basin along the North Fork of Milk River. The surface 2 inches is a black organic sandy mulch. The humus-bearing layer is a dark-brown slightly columnar-structured stony loam. The brown subsurface layer is very gravelly and stony. The gray carbonate zone below 13 to 20 inches is a stony loam, with the lime heavily concentrated in the upper part. The lower soil depths are lime-blotched stony silts and silty clays.

The Croffs loams cover high gravel-capped benches in the central and north-central part of the county, and lower stony benches above Cut Bank Creek and the North Fork of Milk River. The high benches have considerable stone on the surface, which is not as abundant in the soils. The bench between Cut Bank and Greasewood creeks is characterized by low gravelly bars rising 1 to 2 feet above the general level. These loams cover a total area of 123 square miles, of which only a few square miles is sharply rolling. On the land classification map the loams are classified as non-tillable grazing lands. The surface acre-foot of the higher benches contains from 7,000 to 12,000 pounds of nitrogen and 2,450 pounds of phosphorus. The bench between Cut Bank and Greasewood creeks has from 7,000 to 9,000 pounds of nitrogen and 2,100 pounds of phosphorus in the surface acre-foot. The benches lie at an elevation above 4,300 feet, which is near the limit of small grain growing in this part of the state. Spring wheat can possibly be grown on the lower benches below the Canadian line, but it is likely to be caught by early fall frosts in the basin above the North Fork of Milk River. Only feed and forage crops can be successfully grown on the higher parts of the benches above 4,500 feet. The bench between Greasewood and Cut Bank creeks is too stony for farming. The Croffs loams have a good cover of the tall bunch grasses and have a carrying capacity of 10 acres or less per steer.

#### CROFFS STONY LOAMS

The breaks and remnants of the high benches are grouped under the Croffs stony loams. The soils are stony dark-colored loams with carbonate zones below 20 to 30 inches. Below the breaks more or less wash gravel covers the land. Residual material derived from red shales and sandstones underlies the gravels at various depths and where it occurs at the surface the soils grade into the red phase of the Bainville loams. The amount of nitrogen in the surface acre-foot is somewhat lower than that in the Croffs loams, but the amount of phosphorus is about the same. The stony loams cover a total area of 86 square miles, of which 55 square miles is too broken for cultivation. Only a small portion of the level phase is suitable for farming and it lies at an elevation which practically limits the growing of small grains for grain. The land is well covered with bunch grass and has a slightly lower carrying capacity for livestock than the Croffs loams.

**ST. MARY'S STONY LOAMS**

The surface 5 inches of the St. Mary's stony loams at elevations above 5,800 feet on the St. Mary's divide is a black gritty loamy mulch, consisting largely of organic matter. The stony humus-bearing layer is a blocky granular rather compact dark-brown silt loam, with a horizontal cleavage. Below 42 inches the non-calcareous brown stony and gravelly silty clays are without definite structure. At elevations below 5,500 feet a lime-blotched light-brown structureless stony silty clay carbonate zone occurs at depths of 36 to 40 or more inches and the stony subsurface layer has a slight columnar structure. Water-worn quartzite and argillite gravel and rock, having diameters of less than one foot, are quite abundant in all sections. The area covered by lodge pole pine on the St. Mary's divide is shown on the soil map as a phase of the St. Mary's loams. The soils in the more heavily covered timbered sections grade into the gray forested soils. The light-gray ashy layer below the leaf mold is poorly developed.

The soils on the Milk River divide have a black organic mulch, averaging 3 inches thick on the surface. The humus-bearing layer is a dark-brown blocky-structured stony loam of 5 to 7 inches in thickness. The stony subsurface layers grade from compact brown granular silts and silty clays in the upper part to lighter-brown non-calcareous structureless stony silty clays in the lower part. At depths of 58 or more inches reddish silty clay occurs locally below the stony covering.

St. Mary's loams cover the stony-capped plateaus forming the St. Mary's and Milk River divides in the western part of Glacier County. The benches have a gentle slope but are cut with deep stream valleys, the slopes of which are usually smooth and stony. The stony loams cover a total area of 61 square miles of which 18 square miles is too steep for cultivation. The area covered by the United States Geological Survey did not include the high plateaus and mountain slopes in the western part of Glacier County. The surface acre-foot contains from 8,000 to 12,000 pounds of nitrogen and 2,450 to 3,500 pounds of phosphorus. The surface soils do not effervesce with acid, but the calcium content exceeds 12,000 pounds in the surface acre-foot. The plateaus lie above 5,000 feet in elevation and the growing season is too short and cool for the production of small grains except possibly for forage. The land has a dense cover of the tall grasses and a high carrying capacity for livestock. Snow covers the plateaus until late in the spring.

**GLACIER STONY LOAMS**

The surface 3 to 4 inches of the Glacier stony loams consists largely of leaf mold. It is underlain with one-fourth to one-half inch of ashy gray silty material. The surface layer between 4 and 10 inches is a light yellowish-brown compact stony silt loam without definite structure. At 18 inches it grades into a structureless stony

silt loam, mottled and streaked with brown and black organic matter. Below 40 inches the texture changes to a grayish-brown granular stony silt loam, mottled with dark brown patches, and at 84 inches into a more friable light-brown gravelly and stony gritty loam. At 120 inches the color of the stony material changes to a gray or grayish-brown. All sections are non-calcareous, although a portion of the rock consists of limestone. The gray forested soils are in various stages of development in the western part of Glacier County, but only in the more densely timbered sections is the ashy gray silty layer below the leaf mold well developed.

Glacier stony loams cover the more densely wooded slopes of the mountains. Outside of Glacier National Park they cover 60 square miles. The timber consists chiefly of lodge pole pine and the underbrush of shrubs and ferns. The stony loams are grazed by sheep and goats during the short open grazing season.

#### BABB STONY LOAMS AND LOAMS

The Babb series includes a group of undifferentiated timbered soils covered with patches of quaking aspen, willow, and some lodge pole pine. The soils of the open parks have profiles somewhat similar to those of the St. Mary's stony loams and the timbered sections those of the Glacier stony loams. The stony loams cover 229 square miles, consisting largely of the hummocky broken lower slopes of the mountains. The loams cover 20 square miles of open park land. The soils of the Babb series are well covered with vegetation and have a high carrying capacity for sheep and goats. The lower slopes of the mountains are usually open to grazing between June 15 and September 15.

#### ORMAN CLAY LOAMS

The Orman clay loams have a loose granular silty clay mulch on the surface. The humus-bearing layer is a compact cloddy brown silty clay effervescing with acid. It is 4 to 5 inches thick and grades into stratified calcareous compact grayish-brown silts and silty clays with depth. The soils are often flecked with alkali below 15 inches.

The Orman clay loams cover the bottoms of ancient stream courses, such as the sag between the South Fork of Milk River and Rocky Coulee, and the low terrace rising above Spring Creek, south of the Seville bench. The clay loams cover less than 3 square miles, which are shown as non-tillable grazing land on the land classification map. The soils contain a fair amount of nitrogen and phosphorus, but are in general too heavy and retractive for farming. The soils in the sag are also poorly drained. Western wheat grass forms the chief cover and the carrying capacity for livestock is between 25 and 30 acres for each head of cattle.

**CHEYENNE GRAVELLY LOAMS**

The Cheyenne gravelly loams have a loose sandy mulch on the surface. The surface layer is a slightly columnar-structured brown sandy loam to gravelly loam which grades into a lighter-colored more compact subsurface layer at 6 to 8 inches. The carbonate zone below 12 to 20 inches consists largely of stratified sands and gravels. Many of the terraces along the mountain streams are very gravelly and are shown on the soil map as loose gravel deposits.

Cheyenne gravelly loams cover high terraces along the mountain streams in the southern part of the county. The gravelly loams cover 7 square miles which are shown as non-tillable land on the classification map. The sandy loams have a fair amount of nitrogen but are quite variable in the amount of phosphorus. The less gravelly phases are in general too droughty for dry-land farming. The gravelly loams have a fair cover of grama grass and a carrying capacity for livestock around 25 acres per head.

**PHILLIPS LOAMS**

The scabby bottoms of dry upland lakes are grouped with the Phillips loams in Glacier County. Most of the bottoms are poorly drained alkali clays. The bare spots have a firm heavy crust on the surface; below the material has a porous or vascular structure for an inch or more. The lower depths are structureless alkali silty clays. The better-drained phases have a fair grass cover and show a slight soil development. The scabby loams cover 9 square miles of non-tillable grazing land. These bottoms have a low carrying capacity for livestock.

**CHOUTEAU LOAMS**

The Chouteau loams include a group of undifferentiated black stratified soils covering the bottom of streams at the higher elevations in the western part of the county. The soils have no definite horizons except those produced by poor drainage. They range in texture from loams to stony loams. In some of the stream valleys the soils effervesce weakly with acid, where the wash is from sedimentary rocks high in lime. The larger tracts of the Chouteau loams, such as are found along the Middle and South Forks of Milk River, Badger Creek, and the finger lakes in the western part of the county, are quite swampy and poorly drained. The surface acre-foot runs very high in nitrogen and contains a fair amount of phosphorus. The black loams cover 17 square miles which are utilized chiefly for grazing land and hay land. A small acreage around Family is under cultivation. The vegetation consists of willows along the perennial streams and grasses and sedges adapted to poorly drained conditions on the flood plains.

### LAUREL LOAMS

The Laurel loams include a group of undifferentiated gray calcareous stratified soils covering the bottom of streams in the eastern half of the county. This group also includes the gravelly river wash along some of the larger streams heading in the mountains. The bottoms of many of the local upland streams are highly impregnated with alkali and on the soil map are shown as an alkali phase of the Laurel loams. The soils in the lower part of the broad valley of the South Fork of Milk River range from loose gravels along the stream to retractive silty clays below the gravelly benches. Below the mouth of the Middle Fork of Milk River the soils are modified by wash from the red upland shales and sandstones and locally have a dull red color.

In other stream valleys the texture of the soils ranges from loose gravelly sands to heavy clays. The bottoms of the larger stream valleys are more or less terraced and the recent flood plains are often poorly drained. Alluvial fans occur at the mouths of many of the upland streams and stony colluvial material often lies below the sandstone cliffs in the eastern part of the county. The Laurel loams cover 41 square miles, consisting chiefly of non-agricultural land. The loams and silty clay loams contain a fair amount of nitrogen and an average amount of phosphorus. Some of the larger stream bottoms are valuable hay lands, and where the land lies above the spring freshets small tracts may be placed under cultivation. Most of the land is either too droughty or retractive for dry-land farming, and when water is available the land should be placed under irrigation. Willows and a few cottonwoods cover a large portion of the less alkaline and better-drained land in the larger stream valleys. The lower levels often have a dense cover of sedges and other plants adapted to poorly drained conditions. The alkali and colluvial phases are more lightly covered with vegetation. The carrying capacity of the Laurel loams for livestock is quite variable for the different streams, but on the whole averages low.

### LAUREL CLAY LOAMS

The more barren and alkali phases of the stream and lake bottoms, which do not effervesce freely with acid, are grouped in the Laurel clay loams. The soils are gray cloddy stratified silty clays and clays, occurring largely at the head of drainage basins and around lakes. In the valley of the South Fork of Milk River is an isolated tract covered with red silty clays. The clay loams cover 11 square miles of non-agricultural land. The soils are too retractive for farming and are utilized for the grazing of livestock. The soils are usually lightly grassed over and in some of the lake basins grade into grease-wood flats. The land has a low carrying capacity for livestock.

### BAD LANDS

Badlands cover 5 square miles of barren, gullied clay hills and ridges and barren sandstone cliffs and buttes along the South Fork of Milk River in the north-central part of the county and along Two Medicine Creek in the southeastern part. The land is not well covered with grass and has a low carrying capacity for livestock.

### ROUGH BROKEN LAND—MOUNTAINS

Rough broken land covers the greater part of Glacier National Park and 9 square miles outside of the park in Glacier County. It consists largely of bald peaks, barren ridges, talus-covered slopes, and inaccessible timbered areas. Below the timber line lodge pole pine occurs chiefly on the mountain slopes and quaking aspen and willows in the canyons. Sedges predominate over the grasses in the open parks and shrubs form most of the underbrush. Rough broken land has a low carrying capacity for livestock, except for sheep and goats.

### STONY OUTWASH AND GRAVELLY TERRACES

River wash covers the valleys of many of the streams below the mountains and loose gravelly terraces rise above a few of the mountain streams such as Badger Creek. Some of the more gravelly glacial lake basins in the western part of the county are also included in this group. The gravelly lake basins are locally poorly drained and around Blackfoot and Browning the lake bottoms are swampy. The stony gravelly tracts cover an area of 17 square miles. The mountain outwash and gravelly terraces are without a vegetative cover, except for a few willows along the streams. Sedges which are locally cut for hay cover the swampy phases of the gravelly lake basins.

### AGRICULTURE

The area covered by the Blackfeet Indian Reservation is used chiefly for the grazing of livestock. Large tribal herds were run on reservation up to about 1919, when these herds were depleted by the drought of 1917 to 1920. Since this time a large acreage of the Indian lands has been leased by cattle and sheepmen. The past few years a small acreage has been broken and placed in spring wheat and flax in the eastern part of the reservation and with continued favorable seasons the acreage will probably increase rapidly. The development of several irrigation projects by the Indian Reclamation Service has been slow.

The area outside of the reservation was settled and fenced in tracts of 160 and 320 acres and largely broken between the years of 1910 and 1917. The effects of the drought were not so noticeable as in the counties to the east, as only 32.4 per cent of all the farm lands had a mortgage indebtedness of \$6.05 on land valued at \$10.83 per acre in 1925, and the farm tenancy increased only from 4.8 per

cent to 9 per cent between 1920 and 1925. Farm and grazing lands are held at nominal prices ranging from \$15 to \$25 per acre for improved land and \$3 to \$10 per acre for grazing and unimproved farm lands.

The development of agriculture in Glacier County is shown by a few figures taken from the United States agricultural census for 1920 and 1925. In 1920 approximately one-fourth of the total area in the county was in farms and in 1925 slightly over one-half. During this period the number of farms decreased from 372 to 344 and the acreage composing a farm increased from 1465 to 3083 acres. The trend toward larger farm units by combining the original homestead tracts and Indian allotments is more noticeable in Glacier than in the counties to the east. Many of these farms are large stock ranches, with a small acreage broken for winter feed crops, such as oats. The gross agricultural income in Glacier County is derived largely from livestock resources and from products grown on the dry and irrigated farms in the eastern part of the county.

**STOCK RAISING.**—A large portion of Glacier County is too stony and lies at too high an elevation for general farming. Stock raising will be the chief industry in the western half of the county. The wild grasses covering the wet bottoms make a fair quality hay, but during the winter feeding period, usually between December 1 and April 1, the wild hay should be supplemented by the tame grasses, small grain hay, and commercial feeds for best results. In the eastern part of the county the more stony and broken land can be utilized only for grazing. In this part of the county the winter grazing land is supplemented by straw and small grain hays and by such forage crops as alfalfa and sweet clover grown on the dry and irrigated farms. Dairying has possibilities on the irrigated lands and in some of the larger wet bottoms. Most of Glacier County is well watered and in only a few sections is it necessary to provide storage reservoirs for stock.

The beef breeds, such as the Herefords and Shorthorns and their crosses, are chiefly found on the range. The total number of cattle in Glacier County in 1920 was 27,536 and in 1928, 6,379, of which 263 were assessed as dairy cows. The decrease in number of cattle on the reservation was largely due to the liquidation of the larger cattle companies after the severe winter of 1919. The herbaceous forage, forming a large part of the undergrowth in the lower timbered sections, is a better range forage for sheep and goats than for cattle. In this part of the county migratory bands of sheep are run during the summer months. The finer wool bands, such as the Rambouillet and their crosses, are given preference. The number of sheep in the county increased from 16,001 in 1920 to 56,280 in 1928. The number of horses in 1920 was 6,033 and in 1928, 4,340 head were assessed. The swine industry is unimportant as only 252 breeding sows were reported on the dry and irrigated farms in 1928.

TABLE 4.—ACREAGE AND YIELDS OF THE MORE IMPORTANT CROPS  
GROWN IN GLACIER COUNTY

Crops	†*1919		*1924		*1929		**1922-1929	
	Acre- age	Acre yields	Acre- age	Acre yields	Acre- age	Acre yields	Acre- age	Acre yields
		Bu. or tons		Bu. or tons		Bu. or tons		Bu. or tons
Cropped land								
harvested .....	8,078	—	49,989	—	66,796	—	34,457	—
Fallowed land .....	—	—	12,387	—	27,093	—	—	—
Cropped land, total .....	—	—	63,651	—	96,796	—	—	—
Barley .....	25	0.6	616	14.9	444	13.2	829	23.4
Flax .....	2,003	1.9	383	8.4	5,512	7.4	1,068	6.7
Hay, total .....	12,103	0.4	25,079	0.8	23,357	0.8	—	—
Hay, tame, total .....	684	—	2,324	—	—	—	1,671	1.5
Hay, wild, total .....	11,419	0.4	22,755	—	—	—	18,616	0.8
Hay, alfalfa .....	62	1.3	184	—	—	—	—	—
Hay, other legumes and grasses .....	30	—	245	—	—	—	—	—
Hay, small grains cut for hay .....	594	—	1,895	—	—	—	—	—
Oats .....	230	4.4	3,632	22.6	3,142	21.5	4,018	31.8
Potatoes .....	9	60.6	165	75.0	115	40.2	189	77.6
Rye .....	110	1.2	—	—	—	—	1,357	14.0
Wheat, spring .....	4,191	3.0	19,495	12.7	24,764	12.2	21,596	13.3

\*United States census reports.

†Extremely dry year.

\*\*State Department of Agriculture.

DRY-LAND FARMING.—According to the reports of the State Department of Agriculture the average cropped acreage in Glacier County since the drought has been approximately 34,457 acres, of which 21,596 was devoted to spring wheat. The crops grown in this part of the state are the early and medium-early varieties of small grains and forage crops. The more important small grains are wheat, flax, oats, barley, and rye. Fall grains, except fall rye, winter-kill too frequently to be depended upon. Winter wheat is grown on a small acreage in the eastern part of the county. The climate is too cool to mature the dent and semident varieties of corn, although at the lower elevations the flints are locally grown for fodder and hogging off. Most of the oats and barley grown on the dry-land farms is harvested for winter forage. Table 4 gives the acreage and yields of the more important crops grown in the county since 1919.

Sweet clover, brome grass, and western wheat grass are the chief forage crops grown on the dry-land farms. Under dry-land conditions the yields of the grasses and legumes are rather low, and in the drier sections they do not compete with the small grains and wild hay. The yields of root crops, such as potatoes, are fair but the production is not sufficient for local consumption.

On the large grain farms, where 200 to 600 acres or more are annually cropped and an equal acreage summer fallowed, duckfoot

and similar implements drawn by small tractors are used in preparing the land for spring seeding and for summer fallow. Small combine harvesters are generally employed in harvesting the large grain fields.

**IRRIGATION FARMING.**—The irrigated lands in Glacier County are not well developed. In 1928 only 7,321 acres was assessed as irrigated land. Title to a large portion of this acreage was obtained from competent Indians on the reservations. The small grains grown on the irrigated lands are the medium-late varieties, except in the case of spring wheat. Alfalfa is the chief forage crop. At the time of the survey spring wheat was the most important crop grown on the irrigated lands. Oats and alfalfa covered a small acreage. The soil and climatic conditions are favorable for a more diversified type of agriculture in which grain, hay, and livestock are combined. The grasses and legumes do especially well under irrigation in Glacier County and a fair acreage of these forage crops should be grown on most of the irrigated farms for pasture and hay. Small tractors are commonly found on the irrigated farms.

#### SOIL PROBLEMS

Land utilization is probably the most important problem in Glacier County at the present time. On the reservation the land has been allotted to the Indians, except for the tribal timber and mineral lands. In the western half of the county, the non-agricultural lands have a carrying capacity of 40 to 50 head of cattle per section. To insure a fair income from running 250 to 300 head of cattle, five to seven sections of land would be required. In the eastern half of the county the most efficient use of the grazing and farm lands can be obtained by combining grain growing and stockraising. In most localities three or more sections would be required to net fair incomes. On the irrigated lands, devoted largely to pasture and forage crops, 160 to 320 acres would be a fair-sized farm unit.

**DRY-LAND PROBLEMS.**—Exclusive grain growing at the lower elevations in Glacier County usually results in more or less soil drifting, after the root fiber has been destroyed. Cultural methods, such as ridging the land and leaving the stubble on the surface, are the chief means of controlling soil drifting at the present time, although strip farming is locally practiced. Seeding the land to grasses and legumes is more effective in holding the soil in place.

The variations in the yields of small grains in different localities are usually attributed to poor farming, low rainfall, and other factors but rarely to differences in the fertility of the soils. The surface acre-foot of the agricultural areas covered with the lighter-brown group of soils such as the Joplin, Bainville, Cut Bank and Turner, has a lower nitrogen content than the brown and dark-brown groups. After ten or more years of cropping the root fiber is partly destroyed and the yields of small grains on these lighter-colored soils average a few bushels lower per acre than on the

darker-colored soils, containing more organic matter. The phosphorus content of the agricultural soils in Glacier County is not high, but probably sufficient for normal yields of small grains for several generations.

**IRRIGATION PROBLEMS.**—The maintenance of high average yields on the irrigated lands requires close attention to the fertility and physical condition of the soils. The surface acre-foot of the lower irrigated benches and uplands is comparatively low in organic matter. Irrigated crops often make a slow growth in the spring due partly to the small amount of nitrogen available in the soil. The rotation of the small grains with grasses and legumes and the application of barnyard manure would hasten the warming up of the soils and make more nitrogen available to the growing crops. The soils of some of the irrigated projects are also low in phosphorus, and the lighter soil types will probably respond to phosphatic fertilizers. The soils of the irrigated districts are usually high in free lime, except some of the wet bottoms along the larger streams.

Drainage and other irrigation problems have not seriously developed on the small acreage under irrigation in Glacier County. The swales and depressions on the benches are locally becoming seeped and in a few localities alkali is accumulating on the surface. Drainage, management of the heavier soil types, duty of water, and other problems will arise as the projects are developed.

#### IRRIGATION DEVELOPMENT

Construction work on several irrigation projects on the Black-foot Indian Reservation was started about 1910 by the United States Reclamation Service and later turned over to the Indian Reclamation Service. The water for the different projects is obtained from the perennial flow of such streams as Two Medicine, Badger, and Birch creeks, and from storage reservoirs. The Two Medicine unit covers the greater part of the Seville bench, the lower part of the preglacial valley of Cut Bank Creek, and a wide basin below the bench along Flat Coulee, also called Spring Creek. It has a total area of 44,000 acres; laterals have been constructed on 24,000 acres, and water is available for irrigation on 7000 acres. The Turner sandy loams and gravelly loams are the more important soils on the project. The Scobey gravelly loams in the preglacial valley are locally poorly drained and rather droughty. Serious soil and drainage problems will occur on the Pierre clay loams, Laurel clay loams, and Bainville loams in the basin along Spring Creek. The Badger-Fisher unit covers a bench and a rolling residual area west of Birch Creek in Pondera County. The unit covers 30,000 acres, of which 16,000 acres are provided with laterals and 9,000 acres with water. The Scobey silt and silty clay loams and the Joplin loams and sandy loams are the better soils on the project. Serious drainage and soil problems will also occur in the rolling residual area and around the alkali

lakes. The Regan unit covers a rather loose gravelly bench along Badger Creek in the vicinity of Piegan. This unit covers a total area of 3,000 acres, of which 2,200 acres are provided with water. The Cheyenne gravelly loams cover the bench. The Birch Creek unit covers a rolling residual area west of Birch Creek in Pondera and Glacier counties. This unit covers 3,500 acres, of which 2,200 acres are supplied with water. The Bainville loams predominate on the project and more or less difficulty is experienced in irrigating and draining the rolling land. Several proposed projects occur along Cut Bank Creek. The Cut Bank south unit covers 18,000 acres lying largely in the preglacial valley of Cut Bank Creek, and the Cut Bank north unit covers 9,000 acres north of this creek west of Little Rocky Coulee. The Scobey loams and gravelly loams in the uplands would probably be productive irrigated soils.

The Sherburne Lakes in Glacier National Park are storage reservoirs for the Milk River Irrigation Project, located in Milk River Valley in northern Montana. The water for this project is diverted from St. Mary's River at Babb into a feed canal, which parallels the stream for 15 to 20 miles before crossing it and entering a gap into the Willow Creek basin above Spider Lake. The canal follows the south side of the basin and passes through a rolling gap between the high gravel-capped benches into the North Fork of Milk River a short distance below the Canadian line. The canal carries a large volume of water during the summer months.

Small reservoirs and diversion weirs are also found outside of the reservation in the eastern part of the county. The waters of Red Creek are impounded in a fair-sized reservoir in the northeastern corner of the county.

#### FUEL AND WATER RESOURCES

Agricultural development of some sections of Montana is influenced by the fuel and water resources. Most of Glacier County is well supplied with water of an excellent quality for domestic use. The Two Medicine formation underlies the glacial drift and glacial lake and recent stream deposits in the eastern part of the county. The water in the shaly members of the formation is often brackish or alkaline, but the more massive sandstone members usually carry a fair quality of water for domestic use. This formation carries workable beds of coal in several counties to the east, but in Glacier County the coal measures appear to be absent. The Bear Paw shales outcrop in the central part of the county below the gravel-capped benches. Water from this formation is unfit for domestic use. In the western part of the county the shale and sandstone formations carry a fair quality of water. An excellent quality of water is found at various depths on the gravel-capped benches and in the mountains. The fuel resources consist chiefly of timber. Coal is locally mined in neighboring counties and in Canada, but most of it comes from the Havre and Belt coal fields.

**ACKNOWLEDGEMENT**

The field work was conducted by Mr. Robert B. Tootell, temporary assistant in the United States Bureau of Chemistry and Soils, and by the writer. The land classification map of the northern Great Plains, covering the greater part of Glacier County, was obtained through the courtesy of the United States Geological Survey. Mr. William DeYoung, assistant agronomist, and Mr. Ralph O. Lund assisted in the preparation of the maps. The author wishes to express his appreciation of the cordial treatment accorded him by bankers, business men, officials of the Blackfeet Indian Reservation, and county officials of Glacier County, and others who assisted in the preparation of the maps and manuscript.



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