DESCRIPTION OF THE HARTVILLE QUADRANGLE.

By W. T. Nagler Smith.

GEOGRAPHY.

GENERAL RELATIONS.

Area and position.—The Hartville quadrangle extends in latitude from 43° to 43° 30', and in longitude from 104° 30' to 105°. Its length is 34.5 miles (55.5 kilometers) and its average width 25.6 miles (41.2 kilometers), giving an area of 884.85 square miles (2291.7 square kilometers). It includes a little more than one-eighth of Laramie County, Wyo., lying near the center of the northern half of that county. It is situated near the western margin of the Great Plains, along the eastern flank of the Rocky Mountains. West of the quadrangle, at a distance of about 20 miles, is the eastern margin of the Laramie Mountains, of which uplifts the mountainous northern portion of the quadrangle may be considered a part.

TOPOGRAPHY.

Relief.—The range of altitude within the quadrangle is moderate. The greatest difference in elevation amounts to only 2335 feet, and the extraneous height of the region is less than 500 feet. The northern boundary of the quadrangle is a general slope toward North Platte River. The maximum difference in elevation for any one part of the quadrangle is in Haystack Range, on the east side of Whalen Canyon, where the rise from the stream bed to the summit of the range, in a distance of one mile, is nearly 1000 feet.

One of the most marked topographic features of the quadrangle is the cliff whose southern end forms the western wall of Whalen Canyon, and which, beginning at a point about 2 miles east of Guernsey, runs in a north-westerly direction to a point beyond the northern limits of the quadrangle. The height of the cliff ranges within the quadrangle from about 100 feet at the southern end to more than 500 feet at the northern border of the map. While presenting a general slope toward North Platte River, the cliffs are especially abrupt on the south. This region, which forms the most rugged part of the quadrangle, is known as Haystack Range. At several points in the southern half of this range the summits are flat topped, being capped with nearly horizontal strata of the Laramie Mountain, of which uplifts the mountainous northern portion of the quadrangle may be considered a part.

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- The perennial streams of the quadrangle are North Platte and Laramie rivers and Cheyenne, Horseshoe, and Cottonwood creeks. Of these, all except Cottonwood Creek are, or could be, utilized directly for purposes of irrigation. The water supply of the Laramie and the North Platte is so large that these streams would be little affected by the demands made upon them for irrigation within this quadrangle. The supply of water in Cottonwood Creek is not sufficient for irrigating the agricultural lands along its course within the quadrangle, but could be made so by the construction of storage reservoirs higher up the creek. At favorable points on some of the intermittent streams, also, small storage reservoirs might be constructed which would furnish water for irrigating limited areas. In fact, a number of reservoir claims have already been taken up.

- A considerable area along the lower stretches of Horseshoe Creek within this quadrangle is irrigated by canals and ditches. Canals have been built, also, in the valley of the North Platte, near Fort Laramie. The level uplands around Cheyenne are irrigated by ovens and ditches by which water from Laramie River, about 27 miles northwest of Whalen Canyon. About 8 miles northwest of Guernsey, and south of North Platte River, 100 acres have been successfully irrigated by water drawn from the river by two centrifugal pumps. The products of these irrigated areas are alfalda, wheat, oats, corn, potatoes, and other vegetables.

- As is generally the case, culture is determined in the main by geologic and climatic conditions. The climate is comparatively dry and barren to be favorable for any industry but grazing. Not only is the soil thin, but water is scarce. Since the lower strata contain no water-bearing strata, settlements are not numerous. The scattered farms are mainly along the river courses, in the more open parts of the valleys. The southwestern corner of the quadrangle, however, is a marked exception; there the level uplands around Whalen land are extensively cultivated, and settlements have been made at a number of places, the town of Whalen being the center of the agricultural community. Fort Laramie, in the eastern part of the quadrangle, is a small settlement, the remains of a former military and trading post. The town of Guernsey, in the center of the quadrangle, has sprung up in the wake of the Burlington and Missouri River Railroad, while the settlements at Hartville and Whalen, a few miles to the north of Whalen, and near the Carboniferous upland, are small settlements of a more permanent character.

- The roads are rather numerous, and in general are fairly good, considering the character of the country. They follow, for the most part, natural rather than artificial lines, except in the level land region around Whalen, where many of them run along the section lines, a tendency which is increasing as the more or less scattered farms spring up. As a result of the nearly level rainfall and the thin crops, the surface is usually watered by the irrigation of the more nearly level parts of the quadrangle above the river, which from the perennially flowing irrigation of the river is general, to the valleys bordering these streams. Even there, on account of the meandering of the streams, which causes them to swing now on one side, now on the other, against the abrupt cliffs bordering the valley, it is impracticable in some places to run a canal for any great distance.

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Bench. Their strike and dip vary considerably; some of the general directions of strike in Haystack Range are indicated by the directions of the granite and pegmatite dikes. The north-south strike is common to the north and east border of the strip, and the south and west borders are generally south of Sunrise, and follows the form a series of low hills or ridges within the east. These limestones are associated mainly with amphibole-schists.

The limestones on the eastern border of the strip are usually resistant to weathering, and are of the general directions of strike in Haystack Range, including the occurrence at the head of Whalen Canyon, is also of this granite, as, for the most part, the dikes already referred to.

In addition to the granite just described, there are several small areas of granite rocks (mainly of pegmatite and aplite) which form a minor quartzites of the Whalen group are of rather medium to rather coarse-grained, gneissic, amphibole rocks occurring in the schists of the Hartville Canyon, and also as a rather narrow strip along the western side of the canyon. This strip contains some of the general directions of strike in Haystack Range, and a number of the granite rocks subjected to crushing since its intrusion.

The areas at the southern end of Haystack and just northeast of Frederik appear to be composed wholly (except for a few dikes of pegmatite and aplite) of the coarse-grained granite. A considerable part of the area west of Waterhole Ranch, including the occurrence at the head of Whalen Canyon, is also of this granite, as, for the most part, the dikes already referred to.

The area at the south pitch under the Tertiary deposits. The quartzite, though varying in thickness from about 3 to about 20 feet, is persistent over the area of the Guernsey formation exposed in the quadrangle, and is important topographically. The erosion has left it at a number of points capping cliffs and forming flat-topped hills where the strata dip gently into the Carboniferous upland. The northern part of the formation is seen as almost straight line which can be followed nearly the entire length of the ridge, a distance of between 10 and 20 miles. The rocks of the formation outcrop on the unbroken summit of the ridge, except for the step-off at the northerly boundary of the quadrangle to a point east of Hartville.

South of this point they occur as isolated areas on the south slope of Hartville Canyon, and as a rather narrow strip along the western side of the canyon. This strip contains some of the general directions of strike in Haystack Range, and a number of the granite rocks subjected to crushing since its intrusion.

The limestones at the south pitch under the Tertiary deposits. The quartzite, though varying in thickness from about 25 feet to about 200 feet, the variation being due to the irregularities of its upper surface produced by erosion prior to the deposition of the sediments of the overlying Hartville formation.

The following section from near Fairbank will show the general character of the beds composing the formation:

**General character of the beds composing the formation:**

- Carboniferous period.
- Guernsey formation.
- The General stratigraphic column.
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The lowest member of the Guernsey formation is a quartzite, usually light colored or nearly white, often containing small flakes or with a generally reddish tint. Where weathered it is commonly brownish or yellowish. It is in part fine grained, and in part conglomeratic, especially near its base. The original sandstone or conglomerate of which it is composed has been cemented by silica into a hard quartzite. The conglomerate ranges from fine grained to rather coarse grained, and from medium to rather fine grained. The areas at the southern end of Haystack and just northeast of Frederik appear to be composed wholly (except for a few dikes of pegmatite and aplite) of the coarse-grained granite. A considerable part of the area west of Waterhole Ranch, including the occurrence at the head of Whalen Canyon, is also of this granite, as, for the most part, the dikes already referred to.

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The limestones are fine grained and compact,
generally light gray, though frequently with a reddish or purplish tinge, and occasionally of a pale yellowish shade. Many of the beds are nearly horizontal, and a number of them contain imbricate chert (clay) in scattered nodules or strings of nodule, or in thin sheets.

The sandstones are medium grained, and for the most part occur in thin beds intercalated with the limestones. They range in thickness from 6 inches to about 50 feet, the majority of the beds being from 2 to 5 feet thick. Several exhibit cross bedding. The overlying gray or pale buff to nearly white, though a few of the beds are red. Most of the sandstones are more or less calcareous, especially the gray beds.

At the base of the formation is a medium-
grained sandstone, nearly everywhere covered by silts into a hard quartzit. It has an average thickness of about 30 feet, and is generally charac­
terized by a deep brownish color, usually with streaks or patches of white. In places it is entirely white, or shows only a tinge of red. Owing to the erosion of the surface on which these rocks were laid down, the line of contact is very uneven, and occasional tongues of the red quartzite project downward into the rocks beneath, some of them 500 feet or more below the general level of the bottom of the quartzite. These projecting tongues of quartzite form marked features on the face of the mountain, like the memory of a
Gurnsey and on both sides of North Plate River at Fairview (see figs. 3 and 4, on the Illustration sheets). The lower part of the bed, like the basaltic quarries of the Gurnsey formation, is resistive to weathering, and as a consequence we find either the lower quartzite alone, or both beds, with the intervening sandstones and limestones, not only capping the greater part of the cliff which borders the Car­
boniferous upland on the east, but also forming the Carboniferous outcrops in the hills on the east side of
Washo Canyon, and capping wholly or in part
the hills north and south of Waterhole Ranch.

In addition to the sandstones and limestones, there are several beds of shale or clay in the lower portion of the Hartville formation. They are for the most part grayish or light gray, though partly grayish green, or red streaked with green. They tend, in part at least, to separate into this, paper fragments. The rocks of the Hartville formation are in general resistant to weathering, and where they have been exposed by the removal of the over­
lying rocks, or have been cut into by streams, the sandstone and sandstone, which are largely composed tend to form abrupt cliffs. Where erosion is rapid the canyons formed are narrow and steep-walled. This is especially noticeable in the gorges cut by the North Platte, where the cliffs have a maximum height of about 600 feet (see fig. 5, Illustration sheet). Hartville.

The determination of the Hartville and Quincy
formations as of Carboniferous age is based on numerous fossils which were found in several beds of the middle part of the formation and which were identified by Dr. G. H. Gitry, of the United States Geological Survey. The fossils are restricted to a thickness of about 300 feet above the base and entirely within the
northeastern part of the quadrangle, where the overlying brecciated quartzite rocks have been removed. This small mass is part of a larger area extending northward beyond the limit of the fossiliferous part of the formation. The fossils are of about 450 feet, and consist of dark reddish-brown, rather soft sandstone, of medium and nearly uniform grain, with a very small propor­tion of light-colored sandstones in its lower half. The rocks are thin bedded, and here and there these thin bedded layers are distinctly ripple marked. In the occurrence northeast of Caspar the beds have a general northwesterly dip, the angle being very variable, ranging from about 10° to 45°, and being higher on the east than on the west. In the lower third of the formation, there are long, thin lenses or sheets of white limestone, ranging in thickness from a few inches to a few feet. Near the southern end of the area northeast of Caspar, and in the lower half of the formation, thin sheets of white, granular gyspum are common, lying one above another in groups, and separated by thin beds of the red sandstone.

The Spearfish sandstone, being soft, is more rapidly weathered than the rocks immediately above or below and which in part constitute the valley occupied by this formation northward to the Black Hills, and nearly 90 miles to the west. It is not far above these rocks are the hard sandstones and quartzites of the Dakota formation, which characteristically form cliffs and mesas, and are cut by a little below are the beds of the limestones and sandstones of the Hartville formation, both serving to emphasize the contrast of the forms of the rocks in the soft rocks.

No fossils were found in this formation. In the division between the Upper Cretaceous and the Lower Cretaceous, the limestones are thick and consist of a succession of beds which, when dis­
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This of "hobgoks" runs in a northwesterly direction, following the outcrops of the formation. The limestone forms the summits and western slopes of the hills, the eastern slope being developed
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about the size of an elephant. The teeth of this creature occur abundantly in the different beds, especially in the sandstones, which have been observed here is the lower part of the upper beds. There are many local variations in the color of the sandstones, which may occur chiefly in narrow, meandering channels trending north and south, and in the sandstones are generally bordered by abrupt sinuous cliffs. Just to the northeast the formation is in part sandy and shows some concretions. To this formation presents many stratigraphic variations, mainly in the eastern direction. A single layer of these formations is often seen across the entire width of the region, and apparently at some points the formations beneath them, and are probably all of Pleistocene age.

Soils. The soils of the quadrangle are thin, owing largely to the aridity of the climate. Except for the alluvial deposits described in the last section, the soils are closely related to the underlying rocks from which they are derived by weathering. The Arikaree is the only formation present extensive aridly surface sufficiently long for cultivation; but as these rocks do not weather readily, their soils are everywhere thin, and interbeds of the more locally derived limestones of this formation are derived chiefly from the lower alluvial deposits spread over it. Even with the best of weathering the Arikaree has no surface produced by the deeply weathered Arikaree uplands, as regosol soil, is in the southwestern part of the quadrangle. These alluvial deposits rest unconformably upon the formations beneath them, and are probably all of Pleistocene age.

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leys were produced, the anticline on its eastern form­

Ages ago, when the Carboniferous period closed with the deposition of a great series of sandstones and shales, the rocks of the different formations were successively alternated with others of stream erosion, and a great deal of erosion which now extends to the north being thus superimposed on the geologic history of the region. In this process, the original thickness of these deposits at the present time is only a small portion of their original extent, for similar deposits have been found in western Canada. It is probable that during the earlier part of this time short episodes of local lake deposition occurred, but they have been wholly removed by erosion. These conditions continued until the deposition of the Dakota and the Spearfish formations the seas became open once more, though still of only moderate depth, and at one point, southeast of Cassa. Here, where the present gorge of the North Platte turns to the north, it is not by a large open valley, trending west­wise. At the close of the period, the contrast in the topography of the Morrison formations extends from Montana to Oklahoma.

The ore is a variety of hematite, commonly known as "paint ore." It is fine grained and compact, with a red color. This variety is generally characteristic of the sediments of the Cretaceous period, being now enclosed as a narrow strip running to the southeast, extending for considerable distances. The main lode of the ore is still smaller, being confined, so far as known, to a half north of Sunrise. The area of ore is still smaller, being confined, as far as known, to the immediate vicinity of the former mine, and to a narrow strip running to the southeast and northward, across the western slopes of Whalen Canyon. The iron ore occurs both in the limestones and in the schists, being developed mainly and not far from the contact between them. This contact runs just west of the Sunrise iron mine southward, then southerly to the west side of Whalen Canyon.

The deposits in the schists are in general more extensive than those in the limestones, and the latter are mostly restricted to a narrow belt just north of the former mine on the south. The occurrence of iron ore in the schists is everywhere penetrative and extensive, but the ore is not adapted for use as a building stone. The ore is fine grained and compact, with a reddish brown color. The ore is fine grained and compact, with a reddish brown color. The ore is fine grained and compact, with a reddish brown color. The ore is fine grained and compact, with a reddish brown color. The ore is fine grained and compact, with a reddish brown color.
made in these deposits at different points within a radius of 31 miles to the north, west, and south-west of Hartville, and 160 acres in claims have been staked out; but at the time the region was visited none of the material had been put on the market. As the area already explored for this product embraces but a small part of the Hartville formation, and as similar deposits are likely to occur in any of the limestones of this formation, it is probable that only a small proportion of the material has as yet been brought to light.

**Sandstone.**

Sandstones are found in the Guernsey, Hartville, Opalco, Spearfish, Sundance, and Dakota formations, and also in the Tertiary deposits. Those of the Dakota are best adapted for building purposes. Those of the Opalco and Spearfish formations and of the Tertiary rocks lack strength and durability, and this is probably also the case with much or most of the sandstones of the foundation formation. It is possible that some of the sandstones of the Guernsey and Hartville formations might be available for building purposes. They are for the most part light colored, gray and buff, and are generally of medium to fine grain, and more or less firmly cemented with calcite. These sandstone beds, however, are not numerous, and are usually only from 3 to 5 feet in thickness. Further, the fact that they are interbedded with massive limestones would make them less accessible than the Cretaceous sandstones. The Dakota sandstones are generally massive, and the beds average between 10 and 20 feet in thickness. The grain is variable, as is also the texture. While one or two of the beds may approach quartzite in character, the majority have only moderate hardness. Their colors are probably persistent, and their strength and durability are attested by the abruptness of the cliffs which they form wherever they have been cut through by erosion. Sandstones from the same formation, in other localities, have been practically tested as building stones.

**Granite.**

It is possible that the granites of the north-eastern part of the quadrangle might furnish a good quality of building stone. They are moderately coarse grained, and appear to be firm and durable.

**Mica.**

Some of the coarser pegmatites of the quadrangle contain sheets of white mica (muscovite) of considerable size, but so thin and scattered that their economic importance is likely to be small. The mica of these pegmatites was mined to some extent between fifteen and twenty years ago, and some of the product was shipped to the eastern markets.

**Quartz and feldspar.**

The large quartz and feldspar crystals found in these pegmatites might prove of value in the manufacture of glass and pottery.

**Gypsum.**

As has already been mentioned, a white granular gypsum occurs in rather thin beds in the north-western part of the quadrangle, in the lower portion of the Spearfish sandstone. This gypsum has been used locally, by a few settlers, for plaster.

**Fire clay.**

Where the Dakota and lower Cretaceous sandstones are exposed, along the eastern front of the Rocky Mountains, they contain a variable number of interstratified beds of clay or shale. In places some of these shales and clays are found to be refractory and to furnish fire clays of good quality. At this series of rocks occurs within the Hartville quadrangle, it is possible that some of the clays found here may prove to be of such a character.

June, 1901.