DESCRIPTION OF THE COALGATE QUADRANGLE.

By Joseph A. Taft.

GEOGRAPHY.

GENERAL RELATION.

The Coalgate quadrangle is bounded by the meridians 96° and 96° 15', and the parallels 34° 30' and 35°, and thus occupies one-quarter of a degree of the earth's surface. It is 8.44 miles north and south and 28.3 miles wide, and contains 235,264 square miles. The larger part of the quadrangle lies within the bounds of the Ouachita National. A strip of land 3 miles in width in the western part of the quadrangle south of Canadian River is in the Chickasaw Nation. The area north of the Canadian, except a narrow band one mile in width along the western border, is in the Creek Nation; this narrow band is in the Osage Nation.

Three physiographic regions or provinces are represented in this quadrangle, each of which possesses distinctive geographic conditions which have determined its surface form. These provinces are: the Ouachita Mountains Range, the Arkansas Valley region, and the Prairie Plains. These other physiographic provinces enter into the geography of Indian Territory, and will be referred to in the general discussion. These are: the Osage region, whose western end extends into southern Indiana; the Arbuckle Mountains, which are in the central part of the Chickasaw Nation west of the Ouachita Mountains; and the Prairie Plains, which includes the eastern portion of the Osage Nation.

The Ouachita Mountains Range, whose ridges cross the southeastern corner of the Coalgate quadrangle, extends from southeastern Osage County, Missouri, and is 280 miles long. It is characterized by numerous ridges and mountains, bearing generally east and west. Near the western end, however, they trend southeastward and decline rather abruptly to the level of the Red River Plain. Elevations of the Coalgate quadrangle are separated by relatively wide and flat valleys. Those valleys which wind through the mountain range descend gradually to the level of Arkansas Valley and the Red River Plain on either side. Near the eastern end, however, they trend southeastward and decrease rather abruptly to the level of the Red River Plain. Elevations in the southern end of the quadrangle are at an elevation of about 1000 feet above sea level near the western end, and nearly 2000 feet above sea level in the northern part of the quadrangle.

In the northern half of the quadrangle, the streams flow more rapidly and cut deep valleys. They generally have a symmetrical form, with the valleys becoming progressively deeper and narrower as they cut toward the north. The southern two-thirds of the quadrangle, however, are more nearly symmetrical, with the valleys becoming progressively narrower and shallower as they cut toward the south. The three types of topography belonging to the physiographic provinces or regions which have been briefly outlined under the heading "General relations" occupy the entire area of the Coalgate quadrangle, and in describing the topographic features it is necessary to classify them under their respective types: the Ouachita Mountains, the Arkansas Valley, and the Prairie Plains in describing the physiographic type.

Ouachita Mountains Type.—The ridges lying east of North Boggy Creek, in the southeast corner of the quadrangle, belong to the foothills of the Ouachita Mountains, which are a member of the Ouachita Range. They form a series of the ridges of the Arkansas Valley type, which are adjacent on the west, and their separation from the Arkansas Valley type would seem arbitrary, but they were determined by different strata and are generally more elevated. They become gradually more southeasterly, in the region of the highest ridges of Pine Mountain, which lie in the southeastern part of the quadrangle.

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Three main river systems.—The Arkansas, the Canadian, and the Red—drain the whole area of the quadrangle. The Arkansas River, although the streams are separated by narrow and flat valleys. Those valleys which wind through the mountain range descend gradually to the level of Arkansas Valley and the Red River Plain on either side. Near the eastern end, however, they trend southeastward and decrease rather abruptly to the level of the Red River Plain. Elevations in the southern end of the quadrangle are at an elevation of about 1000 feet above sea level near the western end, and nearly 2000 feet above sea level in the northern part of the quadrangle.

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wide and open and no faulting of consequence has occurred. The beds of rock which occur in these folds have had their edges planed off by erosion, so that hard and soft layers are alternately exposed through great thicknesses of strata in nearly level-crested ridges and flat valleys. They extend parallel and nearly straight along the folds, or in curves across their axial portions. The whole series of rocks exposed by this folding aggregates a thickness of nearly 2000 feet and are divided into formations. The areas of Caney shale and Wapakonske limestone occurring in this province in the southeastern corner of the quadrangle are too small to be considered in this connection. The lowest is considered to be the Aoka formation, which is only partially exposed, being concealed in part by the faults in the southwest and southeast limits of the quadrangle. It is composed of shale and sandstone, and, as a result, its surface is generally level.

The Hurshorne sandstones, being composed of many thick beds aggregating nearly 200 feet, makes ridges that lie along the northeastern side of North Boggy Valley and the southern side of Clear Boggy Valley, but is worn down to the level of these valleys in many places.

The McAlister shale, the next succeeding formation, contains but little sandstone and accordingly it forms shallow, wide, and nearly level valleys and plains. This formation is generally parallel with the course of Clear Boggy Valley, so that it is almost entirely covered by their flood plains of strata. Where it occurs, this shale has been removed by erosion, so that hard and soft strata have been exposed, forming low parallel ridges separated by narrow valleys. Many streams cross these sandstones, but their persistent low ridges extend to the flood plains of these streams. In the case of small faults, the trend of the parallel ridges is marked by the sandstones, gradually migrating away from the axis of the fold with the progress of erosion. Figure 1 illustrates the form of the ridges in an antithetic fold at successive stages of erosion. It also illustrates a series of cross sections at intervals along a pitching anticline.

Sections at intervals across either the antithetic passing through Coalgate or that passing through Savanna in the McAlister quadrangle will illustrate many stages of the erosion of the Savanna sandstones from the time when this formation has been exposed at the surface of the earth. In the western part of the quadrangle it has been traced northeastward, passing nearly 10 miles south of the present watered area. From this general course it has been traced northward, passing about 4 feet in elevation towards the central hill. The sand is a fresh sandstone, with hard sandstone floors in the shallow channel or bed in which it was deposited may be observed. The sand is a fresh sandstone, with hard sandstone floors in the shallow channel or bed in which it was deposited may be observed. The sand is a fresh sandstone, with hard sandstone floors in the shallow channel or bed in which it was deposited may be observed. The sand is a fresh sandstone, with hard sandstone floors in the shallow channel or bed in which it was deposited may be observed.
Caraudafaults.

Cayuse shales. The formation in this occurrence is in two small areas in the Coalgate quadrangle. The one in the southwestern corner includes only the upper part of a large outcrop of this formation, which lies east and north of an extensive body of Silurian limestone in the Arbuckle Mountain region. Near the southwestern corner of the quadrangle the Cayuse shales crop in narrow strip along the northwestern rim of Limestone Ridge and extends northeastward into the McAlester quadrangle. The rocks are faulted along the north side of this area, the beds on the east have been thrust up against younger rocks on the west, thereby cutting out the lower part of the shale. Beds of the Atoka formation, which belong stratigraphically 800 feet above the Cayuse shale, lie in contact with the shale on the other side of the fault. In each locality of the Cayuse shale in this quadrangle about 800 feet of rock is exposed, approximately the upper half of the formation. This part of the formation is composed of blue clay shale, with thin beds of clay, chert, laminolitic concretion, and a few blue limestone septaria. In the lower part of the formation, in the adjoining Atoka quadrangle, the blue shale grades into black, friable, bituminous shale with dark-blue limonite segregations. This shale is a few feet thick, is limited to the eastern border of the western end of the quadrangle, and probably does not exceed 100 feet.

Atoka formation. With the exception of thin lenses of limonite and of calcareous clay shale beds, the Atoka beds throughout the western end of the quadrangle in places could not be found. The formation is separated from the shales by thin sandstone strata into divisions varying from thin sheets to beds several hundred feet in thickness. The shales are friable clays and sandy clay shales and they crop out in large bodies. They are occasionally found in thin and sharp beds in the lower slopes of hills which are surrounded by harder rocks of adjacent formations.

The upper beds of Atoka shales, about 10 miles south of the quadrangle, sandstone beds occur at the base. The whole formation gives thin appearance, until but little else than the massive colloite limestone can be found. In Limestone Ridge the limestone is strikingly different in character and in places could not be found. The shales are exposed by the great fault which has thrust them against higher beds in the Atoka formation. The strata in those beds near their upper end have been thrown into peculiar distorted folds, not to be explained except by the great pressure brought about by the upthrust of the old surface upon the observer in the prominent ridges which make that sandstone seems to be a more appropriate term to apply to the formation. There are five, and in some places a number of sandstone beds which vary in thickness from about 20 to 300 feet, those at the top and near the base of the formation being generally thicker. The sandstone beds are so nearly alike in physical appearance that they may be distinguished only by their position in the section, by their thickness, or by the fossil remains which some of them contain. They are generally brown or grayish in color and are sometimes grayish in the weathered exposures at the top of the Atoka formation. They are coarse grained and the sandstone is composed of many beds of sandstone, varying from thin plates to massive slabs 30 to 50 feet thick. Thick beds of shale crop out in a gradual fault which is characteristic of the southeastern part of the quadrangle. They are generally several feet in thickness. They are generally extremely hard in character and would be classed as breccia. The sandstone beds are much thinner in the southeastern corner of the quadrangle. Their presence is so strongly impressed upon the character of the Lehigh coal, which is a prominent feature, however, of the Lehigh formation. The beds of shale in the lower half of the formation are not less than 1500 feet, and the total thickness of the shale is nearly 1000 feet in some parts of the southeastern corner of the quadrangle. They are generally most prominent and produce many low parallel ridges which are separated by the smooth and level surfaces of the flood plains of these streams. The sandstone beds are generally occupied by strips of forest while the valleys are prairie or glady timber land. In the southeastern part of the quadrangle the sandstone beds generally dip at low angles so that the ridges are less prominent and there is less diversity of form.

The extreme of any importance thus far been made by the collection of sandstone beds in the vicinity of Nixon and at other localities in the western part of the quadrangle, but their thickness and extent were not determined.

Baggys. Above the Atoka sandstone there is a mass of shales and sandstones interstrati-}

Fig. 1.—Cast of part of a sandstone (Savanna sandstone) near Coalgate, Oklahoma.

Wapansuck limestone. The Wapansuck limestone forms the eastern border of the Coalgate shale in the southeastern and southwestern corners of the quadrangle. This formation is in an area of considerable faulting, cutting deeply into the shales, and reaching beyond the limits of this quadrangle. It produces ridges, except in those places where the beds have been upturned to a vertical position, thereby permitting the soft shales to be eroded from both sides, leaving the limestone unprotected. The abrupt ending of the formation at the south end of Limestone Ridge is due to its displacement by an extreme fault. Southward the fault follows somewhat the course of Creaky Mountain. The Wapansuck limestone forms the eastern border of the Coalgate quadrangle. The beds at the top of this formation are white, massive, and often calcareous. Cherty sandy limestones and shales occur in the central part of the formation. Below these variable beds, a massive white lime-
beds. As the sandstone beds become thinner they become more shaly and some of them more fossiliferous. Near the northern line of the Ouachita limestone the beds are to be found in this formation in the western part of the quadrangle.

Red River, being high in the series of coalbearing rocks, occurs in the central portion of the synclinal basin and the region of its most distinct

Exposure. In the southwestern part of the quadrangle, in the syncline passing northeast through Lehigh, the beds of the outer portion of the area of this formation dip at angles from 10° to 30° and the sandstone form low erosive ridges. In the larger area, in the central part of the quadrangle, the beds are generally nearly horizontal. By erosion the soft clays and shale beds are removed, leaving the sandstones capping low flat hills and mesas and low gentle-sloping ridges with terraces upon the exposition.

As a result of the broad exposures of sandstone and shale due to the low dip of the rocks, there are peculiar surface spaces quite extensive stretches of hilly timber land and still broader areas of smooth gray plains, corresponding respectively to the sandstone and shale areas.

Thurman sandstone. The Thurman sandstone represents the beginning of a marked change in the character of the sediments which were brought into the sea and spread across this region in the stage of the Senora formation.

Shales and fine sandy sediments of the Boggy shale are formed over coarse pebbles of the Lodo formation and the fine pebbles of the Washita formation. The Washita formation is the oldest part of the series in the southeastern part of the quadrangle, and a well-preserved section has been exposed in a small area in the northwestern corner of the quadrangle.

The sandstone grade into the succeeding Wetumka formation.

The soils produced from this formation are generally more fertile than those of the shaly formation in the southern part of the quadrangle.


e) The land surface of the Calvin sandstone area in the northern part of the quadrangle, especially in the southern part, is more deeply eroded than the country bordered by heavy forest.

Wetumka shale. This shale, 200 feet in thickness, rests upon the Calvin sandstone, and the contact in the quadrangle is limited to a small area in the southeastern part of the quadrangle. The soils developed over the Wetumka shale tend to be more fertile than the soils of the succeeding formations in this region. Beds near the top are exposed in many places in the escarpment beneath the sandstone beds of the succeeding Wewoka formation. In the western part of this occurrence the Wewoka shale lies in the nearly level plain of Muddy Boggy Creek Valley.

Wewoka formation. Above the Wewoka formation, in Carboniferous, is the Senora formation,

The soil of this formation is composed of friable, limy-clay shale, and is of good quality for agricultural purposes. The surface of the formation therefore becomes broader northward in the more level country about Holdenville, and it is here that the formation is best developed. The soils of this formation are composed of friable, limy-clay shale, and are of good agricultural quality. The surface of the formation is broader northward in the more level country than about Holdenville, and it is here that the formation is best developed. The soils of this formation are composed of friable, limy-clay shale, and are of good agricultural quality.
Taking the McAlester formation as it is shown in face of the cut being presented to view. By land and their tilting, folding, and breaking are a depth of 2500 feet below the level of the sea, the troughs and basins are termed anticlines and synclines, respectively. When the strata are broken due to forces of deformation within the earth. Their elevation into chocolate-colored clays. Arches and domes and bendings downward into synclines, bendings upward into anticlines. The narrow, overturned, and broken folds to the southeast end of the section brings it to the southeastern end of the section. In section B-B the top of the Atoka formation would be 1000 feet above the present level of the land in the valley of Coal Creek and probably 2500 feet above the surface of the ground as it was built near the southeastern end of the section. Southeast of this fault the section shows steeply inclined and overturned strata which occur below the McAlester formation and which have been thrust upward and folded to the northwest. In a similar way the southern end of section C-C shows an uplift which strongly tilts the McAlester shale and associated formations and is this structure a part of an uplift of peculiar folding and faulting, in which the Arbuckle Mountains to the southwest are involved, and is but imperfectly represented in this quadrangle. All the strata between show the northern two-thirds of the quadrangle with evenly strata dipping at a very low angle toward the northwest.

STRUCTURE OF THE ROOKS.

The rocks of the Coalgate quadrangle have been affected by forces producing four distinct forms of folded structure occupying separate areas, from the country rock, are blue, tan, brown, and chocolate. These are the Arbuckle Mountains, southeast of the Coalgate quadrangle, and are not of sufficient importance to be mapped. Toward its source, Canadian River flows across flat Carboniferous and younger formations in the region where the strata dip steeply toward the southeast. These structures of the Arkansas Valley region. In the western part of the Ouachita uplift, which are now exposed in the center of the uplift were tilted, folded, and faulted. This uplift is a broad, wrinkled and broken fault. The wavy outcrop of the Wapanucka limestone is a gradual change northward from the overthrust thrust broken folds into the more symmetrical structures of the Arkansa Valley region. In the western part of the Coalgate quadrangle, they are the exposed edges of these inclined strata dipping at a very low angle toward the southeast. The Kiowa syncline, which, within the Coalgate quadrangle, lies between the Savanna and Coalgate anticlines, bears eastward from the McAlester quadrangle, and may have been covered by the sea. At the southeastern end of the section brings it to the southeastern end of the section. In a similar way the southern end of section C-C shows an uplift which strongly tilts the McAlester shale and associated formations and is this structure a part of an uplift of peculiar folding and faulting, in which the Arbuckle Mountains to the southwest are involved, and is but imperfectly represented in this quadrangle. All the strata between show the northern two-thirds of the quadrangle with evenly strata dipping at a very low angle toward the northwest.

PERFORATION.

River sand—All the large creeks and rivers in the Coalgate quadrangle carry sand and gravel which are laid down at their mouth and are not of sufficient importance to be mapped. Generally the sand becomes coarse and is not of sufficient importance to be mapped. Generally the sand becomes coarse and is not of sufficient importance to be mapped.
in the formations which are outlined on the map. These formations which contain the most profitable beds of coal, limestone, and sandstone are emphasized on the economic sheet. Nothing very definite is known of the quality of the clays. Special tests are required to determine whether a clay will produce fire brick, for instance, or may be serviceable in the manufacture of cement, or is suitable for other purposes to which clays are adapted. Clays occur in most of these formations in great quantity, and it is deemed important to point out their occurrence and condition of structure, so that the future those who wish may investigate them to the best advantage.

COAL.

There are two beds of coal of workable thickness both of which are in the McAlester shale. One occurs very near the base and the other about 200 feet below the top of the formation.

The lower bed, which is known locally as the Atoka coal, is about 4 feet thick and has shale in contact both above and below. This coal occupies the same stratigraphic position as the Hardhome coal which is worked extensively in the eastern part of the Osage Nation. It has been worked in this vicinity at what is known locally as the Hickory Hill mine, which is near the south end of the Lehigh Basin, 9 miles south of Coalgate. The coal at this mine dips to the northeast about 4°. It has been prospected at many places east and west of the mine in the southeastern part of the basin. Coal at this horizon crops on the south side of Clear Boggy and Goose Creek valleys and has been prospected at Oucoos and a number of other places. The dip of the coal and associated rocks is about 7° toward the northeast. In the southeastern part of the quadrangle the rocks at this coal horizon dip 60° to 80° to the northeast, but the coal is not known to occur here. If it should be found, however, it probably could not be successfully or profitably mined on account of the steep dip of the rock and the swampy condition of the land.

The coal as it occurs at the Hickory Hill mine, now being worked, by sloping down 400 feet, is laminated and breaks in mining into cuboidal blocks. In the joints of the coal and in places in the limestone there are thin filaments of iron sulphide, and near the surface there is sulphite of lime. The coal is highly bituminous and is used chiefly for steam purposes.

The upper coal in the McAlester shale is known locally as the Lehigh bed on account of its most extensive development at the town of Lehigh, 9 miles south of Phillips. This coal runs regularly about 4 feet in thickness and is without shale partings, as far as known. It is not known in the southwestern part of the quadrangle because its crop occurs in the swampy area of Clear Boggy and Goose Creek valleys. It crops in Coal Creek, 2 miles west of the border of the quadrangle, near the southeastern corner of the Atoka quadrangle. It occurs in a single occurrence, and these may be utilized in the manufacture of lime. These beds are rather hard, and they may be found in dimensions which render them economically workable for foundations, bridge piers, and for general building purposes. The middle and lower beds contain coal and are interstratified with chert and sandy layers, and they may be used profitably for road material. The Missouri, Kansas and Texas Railroad has established a crushing plant at Chickasha switch, near the eastern border of the quadrangle, and has utilized the limestone and chert very extensively for its road ballast. The limestone beds which occur locally in the Savanna, Wewoka, and Holdenville formations are too thin to be profitably utilized.

LIMESTONE.

The Wapanucka limestone is the only formation in this quadrangle containing lime of any importance. The formation crops in limestone ridges from the southeastern corner of the quadrangle northward across the McAlester quadrangle and from the southwest corner southward nearly to the center of the Atoka quadrangle. It occurs in ample abundance for any purpose to which it may be applied. The beds of pryer limestone in the upper part of the formation, and these may be utilized in the manufacture of lime. These beds are rather hard, and they may be found in dimensions which render them economically workable for foundations, bridge piers, and for general building purposes. The middle and lower beds contain coal and are interstratified with chert and sandy layers, and they may be used profitably for road material. The Missouri, Kansas and Texas Railroad has established a crushing plant at Chickasha switch, near the eastern border of the quadrangle, and has utilized the limestone and chert very extensively for its road ballast. The limestone beds which occur locally in the Savanna, Wewoka, and Holdenville formations are too thin to be profitably utilized.

SANDSTONE.

Bed of sandstone occurs in the Savanna, Boggy, Thurman, Senora, and Calvin formations which may be serviceable in many ways as building materials. Many of the beds, and especially those of the upper part of the Savanna formation, produce excellent building stones. The color of the Savanna stone is yellowish or reddish brown, and the beds are evenly stratified and moderately hard. This stone is quarried successfully in large quantities for dwelling and business houses in South McAlester, in the adjoining quadrangle, where the Missouri, Kansas and Texas Railroad crosses the formation. The thinner and harder beds in this and the Boggy formation will serve as paving materials.

The Thurman, Senora, and Calvin formations, especially in their northern parts, contain stones which may be utilized for various building purposes. Certain sandstone strata in the central part of the Stuart formation also may contain beds of workable stones. In the southern and western parts of the outcrop of these formations the sandstones are generally softer, the sand grains which compose them being less strongly cemented together. All of the sandstone beds referred to are fine grained, and yellowish or reddish brown in color. The cement material which binds the sand is composed either of silica or of silica and oxide of iron together. In the lighter-colored stones the cement is chiefly silica, while in the darker it is in large part an iron oxide. Both are very durable in color as well as strength.

CLAY.

Clay and sand are the most abundant of the three great classes of rocks which occur in this region. They are found in thin strata and of local extent in the Wapanucka limestone, Harts horn sandstone, Thurman sandstones, Calvin sandstones, and Gassie sand. In all the other formations, except the Seminole conglomerate, beds of clay and clay shale occur in great abundance. These vary in quality from very easy strata to poorer varieties of finely laminated clays.

Associated with clays, usually at their lower contact, are beds of almost structureless blue clay. These beds are not generally thick, but the clay may prove valuable in the manufacture of brick. These and other clays associated with the coal may be utilized more economically than others because of their proximity to fuel.

The clay shales vary in hardness usually with the amount of sand and other impurities contained in them. The more impure varieties are almost useless in building, while the purer kinds are friable and upon slight weathering are often useless in building.

The structure of the formations in which the clays occur has been sufficiently explained, it is believed, to show where they may be profitably exploited.

March, 1901.