DESCRIPTION OF THE Winslow QUADRANGLE.

By A. H. Purdy.

INTRODUCTION.

LOCATION AND AREA.

The Winslow quadrangle lies mainly in the western part of Arkansas, north of Arkansas River. It is bounded by parallels 35° 30' and 36° and meridians 94° and 94° 30'. Its area is about 34 square miles. Its area is about 34 square miles. Nearly 29 square miles in the southwestern quarter of the quadrangle lie in Indian Territory. The area in Arkansas includes most of Crawford County, a small part of Franklin County, and the southern half of Washington County except a narrow strip along the eastern side.

GENERAL GEOGRAPHY OF THE OKAHR EROSION.

LIMITS OF THE REGION.

The Winslow quadrangle lies within the Ozark region, known in geological literature as the Ozark uplift. This physiographic region extends from the lowlands bordering Missouri River about 18 miles to the Arkansas Valley, and from Neosho or Grand River, in Indian Territory, eastward to the Tertiary lowlands of southwestern Missouri and eastern Arkansas, its area comprising about 400,000 square miles. The region is roughly bounded by a ridge, which is a major southward extension from the St. Francis Mountains. 

The Ozark uplift is bounded by the Arkansas Valley, a synclinal trough extending east and west, which has been reduced by erosion to a plain about 30 miles wide having an average elevation of about 500 feet above sea level. Upon this plain stand Sugarloaf Mountains, Magazine Mountains, Mount Nebo, Carrot Creek Mountains, Petit Jean Mountain, and other elevations of less prominence, besides numerous low, parallel, east-west ridges. The highest point is the summit of Magazine Mountain, which stands about 2800 feet above sea level.

DIVISION OF THE REGION.

The Ozark region consists of two areas, a northern area which is a narrow strip of land lying between the eastern side of the Ozark Plateau and the Mississippi Valley, and a southern area which is the Boston Mountains.

THE OZARK PLATEAU.

Location and surface features.

The Ozark Plateau occupies all the Ozark region of Missouri, most of that of Indian Territory, and a strip about 40 miles wide in northern Arkansas. In the eastern part of this plateau there is a group of peaks collectively known as the St. Francois Mountains, which is the western side of the Ozark Plateau, and the north and southeast is the Boston Mountains.

The surface of the Ozark Plateau slopes both to east and to west, with a general slope of the plateau, to the lowlands of the Arkansas Valley. The topography of the plateau is rugged. In Arkansas, just within the Ozark Uplift, the eastern border of the Ozark Plateau is marked by numerous escarpments and benches.

THE BOSTON MOUNTAINS.

Location and surface features.

Along the southern border of the Ozark Plateau, at a higher elevation, a series of low hills forms a step in the Ozark Mountains. These hills are separated by valleys which extend east and west approximately 200 miles from Grand River, in Indian Territory, to the Tertiary lowlands of eastern Missouri. The highest point of this step is near the summit of Mount Nebo, which stands about 2800 feet above sea level.

This area is essentially a plateau, into which numerous streams have cut deep, narrow valleys. The streams of this area have long and gradual courses, giving the plateau a generally flat appearance. The area is divided into north and south slopes by the lowland of the Arkansas Valley. The highest point of the area is near the eastern border, at the village of Summertown, which is about 2250 feet above sea level.

Northward drainage.

The streams of the Ozark Plateau flow northward, westward, and southwestward. A series of streams, which flow into the Arkansas Valley, form a series of low, poorly defined west-east ridges along the southern border of the quadrangle. The area is divided into north and south slopes by the lowland of the Arkansas Valley. The highest point of the area is near the eastern border, at the village of Summertown, which is about 2250 feet above sea level.

Eastward drainage.

The streams of the Ozark Plateau flow northward, westward, and southwestward. A series of streams, which flow into the Arkansas Valley, form a series of low, poorly defined west-east ridges along the southern border of the quadrangle. The area is divided into north and south slopes by the lowland of the Arkansas Valley. The highest point of the area is near the eastern border, at the village of Summertown, which is about 2250 feet above sea level.

Westward drainage.

The streams of the Ozark Plateau flow northward, westward, and southwestward. A series of streams, which flow into the Arkansas Valley, form a series of low, poorly defined west-east ridges along the southern border of the quadrangle. The area is divided into north and south slopes by the lowland of the Arkansas Valley. The highest point of the area is near the eastern border, at the village of Summertown, which is about 2250 feet above sea level.

Southward drainage.

The streams of the Ozark Plateau flow northward, westward, and southwestward. A series of streams, which flow into the Arkansas Valley, form a series of low, poorly defined west-east ridges along the southern border of the quadrangle. The area is divided into north and south slopes by the lowland of the Arkansas Valley. The highest point of the area is near the eastern border, at the village of Summertown, which is about 2250 feet above sea level.
The rocks of the Ozark region comprise strata representing all the systems from the pre-Cambrian to the recent. The rocks are divided into three periods, the pre-Cambrian, Cambrian, and Ordovician. The pre-Cambrian is the oldest and consists of rocks that have been consolidated into sedimentary rock. The Cambrian period saw the beginning of life on Earth, and the Ordovician period saw the development of many new animal species. The rocks in the Ozark region are all of Carboniferous age, both the Mississippian and the Pennsylvanian series being represented.

The aggregate thickness of the known Paleozoic and Mesozoic strata is 4000 feet, and the average stage, it filters from pocket to pocket into the black clay shales beneath. The shales containing and spread out over the bottom of the sea when the seas at that time. The rocks are unmetamorphosed; that is, except that they have been consolidated, they have suffered little change since they were laid down. No igneous or volcanic rocks occur at the surface within the quadrangle. The surface is mainly level and bears a great deal of chert debris, which in some places has accumulated to a thickness of several inches, and in others it is mixed with clay soil. Both the chert and the clay are residual products, resulting from the removal of the soluble portion of the rock by ground water.

The rocks of the Ozark region are of sedimentary origin, and consist of sandstones, shales, and limestones. The sandstones belong to each, are shown below:

- **Carboniferous period:**
  - **Pre-Cambrian:**
    - *Window formation.*
    - *Morrison formation.*
    - *Fayetteville formation.*
    - *St. Joe formation.*
    - *Boone formation.*

**Mississippian series.**
- *St. Joe limestone.*
- *Bassettville sandstone.*
- *Batesville sandstone.*
- *Arkansasville sandstone.*
- *Eocene period:*
  - *Moyers formation.*
  - *Sharon formation.*
  - *Pottsville formation.*
  - *Benton formation.*
  - *Hale formation.*

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- *Boone formation.*

**Entire region:**
- *Fayetteville formation.*

**Entire region:**
- *St. Joe limestone.*

**Entire region:**
- *Arkansasville sandstone.*

**Cretaceous period:**
- *Cretaceous formation.*

**Quaternary period:**
- *Pleistocene formation.*

**Quaternary period:**
- *Holocene formation.*

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- *Recent formation.*

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stone, known as the Wellington sandstone. The total thickness of the formation ranges from about 150 feet east of Tolu to about 300 feet in the northeastern part of the Floyd quadrangle. It generally attains its maximum thickness in the southeastern part of the Floyd quadrangle, where it is about 45 feet thick. The lower 50 feet of the formation is sandy shale, with two limestone lentils, the Bloyd shale, and a bed of coal which increases southward. At the head of a small ravine leading into Lee Creek, 2 miles north of Berlin, the limestone of this member is at least 40 feet thick and some years ago was utilized for masonry.

Fossils.—A study of the fossils from the different formations of the area shows that the limestone here lies at the top of the Mississippian series and is overlain by the Pennsylvania series of the Carboniferous system. The fossils are all of late Chester age and consist principally of brachiopods and bryozoans. Some species of Eupachycrinus, Paleocrinus, and Productus, Spirifer increbescens, are abundant in the shales. In the basal limestone, perhaps the most striking and characteristic fossil is an undetermined genus of the Wedington sandstone. Theupper portion of the formation, the Hale and Floyd, comprising the Morrow group, and the Winslow formation, is overlain by the Pennsylvanian system. General character.—The thickness of the Hale limestone is appreciable. As a distinguishable vein lying among the other formations, its thickness ranges from about 100 to 200 feet in some places. Its basal portion, the Floyd limestone, consists of sandy shale and limestone; the upper 1700 feet of shale and limestone, the shales greatly predominating. Probably less than 250 feet of the entire formation is limestone. The series is divided into three formations, the Hale and Floyd, comprising the Morrow group, and the Winslow formation, from the northwest to the southeast. The thick beds are commonly 30 feet thick and may be seen in the area of the northern part of the Floyd quadrangle. The lower portion of the formation includes a series of similar escarpments and benches that are almost continuous from Kessler Mountain, in the Fayetteville quadrangle, to the northeast. Its full eastern extent is shown here approximates 2000 feet. The lower portion is along Cove Creek. Its basal portion, usually an inch or less across, and belonging to the genus Michelinia, is perhaps the most common and characteristic fossil of these limestone lentils. Certain layers of the Brentwood are locally filled with conglomerate, and pebbles of many kinds; others are made up entirely of detritus and fossiliferous sandstone. While the fossils of the limestone are in large part new to science, critical comparisons with described species show clearly that it is more closely related to well-known Pennsylvanian fauna than to any known fauna in the Mississippian series. The fact that marine faunas of Potomac age had been hitherto almost unknown imparts unusual interest to their occurrence in the fossiliferous portions of the area. At the same time it explains their strange aspect when compared with described forms.

BLOYD SHALE.

The shale is well developed, and the formations above it are marked by a series of similar escarpments and benches that are almost continuous from Kessler Mountain, in the Fayetteville quadrangle, to the northeast. Its full eastern extent is shown here approximates 2000 feet. The lower portion is along Cove Creek. Its basal portion, usually an inch or less across, and belonging to the genus Michelinia, is perhaps the most common and characteristic fossil of these limestone lentils. Certain layers of the Brentwood are locally filled with conglomerate, and pebbles of many kinds; others are made up entirely of detritus and fossiliferous sandstone. While the fossils of the limestone are in large part new to science, critical comparisons with described species show clearly that it is more closely related to well-known Pennsylvanian fauna than to any known fauna in the Mississippian series. The fact that marine faunas of Potomac age had been hitherto almost unknown imparts unusual interest to their occurrence in the fossiliferous portions of the area. At the same time it explains their strange aspect when compared with described forms.

Pennsylvania system.

The rocks of the Pennsylvania series constitute the great mass of the Boston Mountains. To this series belong all the rocks above the Pitkin limestone, and the north slopes and all the south slopes except those at a few places, of rather small size, where the other rocks have been cut through by the weathering and removal of the shale below, it breaks off in enormous blocks, leaving a steep escarpment. In the area of its outcrop this formation generally outcrops as a steep escarpment, where the lower portion is a sandstone; the upper 1700 feet of shale and limestone, the shales greatly predominating. Probably less than 250 feet of the entire formation is limestone. The series is divided into three formations, the Hale and Floyd, comprising the Morrow group, and the Winslow formation, from the northwest to the southeast. The thick beds are commonly 30 feet thick and may be seen in the area of the northern part of the Floyd quadrangle. The lower portion of the formation includes a series of similar escarpments and benches that are almost continuous from Kessler Mountain, in the Fayetteville quadrangle, to the northeast. Its full eastern extent is shown here approximates 2000 feet. The lower portion is along Cove Creek. Its basal portion, usually an inch or less across, and belonging to the genus Michelinia, is perhaps the most common and characteristic fossil of these limestone lentils. Certain layers of the Brentwood are locally filled with conglomerate, and pebbles of many kinds; others are made up entirely of detritus and fossiliferous sandstone. While the fossils of the limestone are in large part new to science, critical comparisons with described species show clearly that it is more closely related to well-known Pennsylvanian fauna than to any known fauna in the Mississippian series. The fact that marine faunas of Potomac age had been hitherto almost unknown imparts unusual interest to their occurrence in the fossiliferous portions of the area. At the same time it explains their strange aspect when compared with described forms.
Subdivision.—It was not found practicable to divide the formation in the Window quadrangle, because of the general similarity of the rocks from its base to its top, yet it is elsewhere subdivided into two parts, which here pass imperceptibly into each other. The upper portion may correspond to the Akins shale member of the Winslow, described in the Tishomingo quadrangle.

The lower portion of the Window contains most of the sandstone of the formation, and the sandstone constitutes in it about 90 per cent of the rocks, the remainder being shales and a thin bed of coal. Unusual-shaped portions of the shaly sandstone present a massive appearance, but on exposure the bedding planes are developed and the shaly appearance follows. The rapid weathering of this rock and the shales beneath it underlines the massive layers and forms the steeper and most pronounced escarpments of the region, which conspicuously marks the dividing line between the Morrow group and the Window formation. The occurrence of the basal layer of the sandstone, with its shales beneath it, is repeated in the several sandstone beds above it. In none of the other massive portion of which, however, in the base one, except in certain beds about 100 feet thick in the upper portion along Prg. Bayou, just south of Loxomia. Where this problem is not exposed elsewhere, it appears that at the point mentioned they are the result of the structure of the country around it.

The thickness of the lower portion is not determined, but it probably exceeds 1500 feet. There are 900 feet exposed north of Rollinsville, near the eastern border of the quadrangle. In Limestone county, the thickness is at least 1000 feet. A mile south of Rury, near the railroad a well-drilled in the depth of 1409 feet, apparently without reaching the Floyd formation beneath.

The upper portion of the Window formation is the upper rock in the southwestern part of the quadrangle from Prg. Burn Creek, from which they extend as one fold in the southwestern direction of the quadrangle. This struktural feature is well marked at the bend of the railroad above the town of Rury, and is therefore called the Rury monocline. On the usual geology maps these folds can be traced by lines of lower formations, such as the Pitkin and Helsup, in the deep revetted section of the divide, where these lower rocks have been cut into along the tops of the folds and are thus exposed over small areas, as shown to the map.

SOUTH WINDING COAL.

In the northern part of the St. Francis Mountains, the thickness is at least 1000 feet. A mile south of Rury, near the railroad, the town of Frisco, just north of the escarpment bordering the Arkansas Valley in Lefayette and Van Pinda townships. The downthrow is on the southeast side. The amount of the lift here is uncertain, but it is a thin bed of coal cropping in the southern part of sec. 21, T. 19 N., R. 30 W., at an elevation of about 350 feet, is the thinnest known. The throw is about 300 feet. The amount of downthrow decreases rapidly northward and westward. There is not much evidence of structural disturbance in the southern part of sec. 13, T. 30 N., R. 29 W., at an elevation of about 350 feet, the throw is about 50 feet. The agreement in the thickness, character, and stratigraphic relations of these coals indicates that they are the same bed.

Window coal fault.—Of the east-west faults the most pronounced is the one along Evansville Creek, extending eastward beyond Fall Creek. The same general line of disturbance is indicated by the Frisco monocline fold, which is notably displayed on Lee Creek near the Washington-Crawford county line, and in the fault north of the town of Porter.

Along Cove Creek where the fault crosses the Price Mountain fault the structure is somewhat obscured by warping. The Price Mountain fault brings the base of the Window in the northwestern part of the quadrangle downward into the area of the compliance of the region. This is the fault along the escarpment in the southern part of the town of Porter. Along the railroad above the town of Frisco and is there down to the level of the Brentwood limestone in the southeast part of the town of Porter. The fault along the escarpment bordering the Arkansas Valley in Lefayette and Van Pinda townships. The downthrow is on the southeast side. The amount of the lift here is uncertain, but it is a thin bed of coal cropping in the southern part of sec. 21, T. 19 N., R. 30 W., at an elevation of about 350 feet, is the thinnest known. The throw is about 300 feet. The amount of downthrow decreases rapidly northward and westward. There is not much evidence of structural disturbance in the southern part of sec. 13, T. 30 N., R. 29 W., at an elevation of about 350 feet, the throw is about 50 feet. The agreement in the thickness, character, and stratigraphic relations of these coals indicates that they are the same bed.
HISTORICAL GEOLOGY.

General historical events.—Probably from Archaen time, during long geologic periods, the region, by eroding and sedimentation, underwent continual modification. As a result, the present area of the Boston Mountains and adjacent regions was covered by the waters of the ocean, and the parts of it were temporarily uplifted into land areas.

The final emergence of the Ozark area began with the rifting of the Ordovician southern Appalachian sea. The gradual orogenic movements, extending over many millions of years, resulted in the deposition of sandstones and shales. The Boston Mountain region formed an area of subsidence during this time, as shown by the thick deposits of Ordovician rocks.

During this time, denudation was going on over the Ozark Plateau, and the coastal material resulting therefrom was carried by streams and deposited on the present area of the Boston Mountains and further south along the Arkansas Valley. Thus the Boston Mountain region formed an area of subsidence during this time, as shown by the thick deposits of Ordovician rocks.

The plateaus of other areas that are a part of the Ozark region are composed of Precambrian rocks, while the Boston Mountain region is composed of younger rocks. Most of the Precambrian rocks that are found in the Boston Mountain region are sandstones and shales. These rocks are generally characterized by their fine-grained texture and are often used as a source of building stone.

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Local geography in Silurian time.

The Silurian period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Silurian period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

Local geography in Carboniferous time.

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Local geography in Mississippian time.

The Mississippian period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Mississippian period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

Local geography in Pennsylvanian time.

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Local geography in Permian time.

The Permian period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Permian period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

Local geography in Triassic time.

During this time, denudation was going on over the Ozark Plateau, and the coastal material resulting therefrom was carried by streams and deposited on the present area of the Boston Mountains and further south along the Arkansas Valley. Thus the Boston Mountain region formed an area of subsidence during this time, as shown by the thick deposits of Ordovician rocks.

Local geography in Jurassic time.

The Jurassic period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Jurassic period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

Local geography in Cretaceous time.

During this time, denudation was going on over the Ozark Plateau, and the coastal material resulting therefrom was carried by streams and deposited on the present area of the Boston Mountains and further south along the Arkansas Valley. Thus the Boston Mountain region formed an area of subsidence during this time, as shown by the thick deposits of Ordovician rocks.

Local geography in Tertiary time.

The Tertiary period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Tertiary period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

Local geography in Quaternary time.

During this time, denudation was going on over the Ozark Plateau, and the coastal material resulting therefrom was carried by streams and deposited on the present area of the Boston Mountains and further south along the Arkansas Valley. Thus the Boston Mountain region formed an area of subsidence during this time, as shown by the thick deposits of Ordovician rocks.

Local geography in Holocene time.

The Holocene period is characterized by the deposition of fine-grained sediments, which are typically found in the Boston Mountain region. These sediments are often rich in fossil remains, and they provide important clues about the ancient environment in which they were deposited. The Holocene period is also marked by the firstappearance of land plants and animals, which indicates the beginning of a new phase in Earth's history.

PHYSIOGRAPHIC RECORD.

Occlusions of the region.—The forces which produced the afore-mentioned uplift and which resulted in the folding of the rocks along east-west lines of the Boston Mountains, as well as the uplift of the Boston Mountains, are not well understood. However, it should be remembered that a monoclinal fold, which has already been described under the heading "Structure and geology," extends southward from near the summit of the eastern part of the Boston Mountains. The present height of the Boston Mountains is the result of the uplift of the area which is now the north part of the Boston Mountains. The last subsidence occurred during Tertiary time, and the following uplift forced the water level back to its present position.

The structure of the Boston region is the combined result of several forces, including the initial uplift from the sea and its subsequent movements. The presence of the unconformity and the amount of its occurrence is in the Boston region is the result of the uplift of the area which is now the north part of the Boston Mountains. The last subsidence occurred during Tertiary time, and the following uplift forced the water level back to its present position.

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along the small streams the rocks of the anticline are there least removed. Their preservation in place is due to the fact that these beds are in part composed, and which is able to withstand erosion for a long time. Most important of all is the fact that the several streams which have eroded the Pinck, owing to the large amount of silt that is included in these formations, have been eroded by several thousand years. The water from the Win- low formation is hard, having high lime with silica. That from the Boise and Hale, while hard, contain a considerable amount of silica, and it is expected that if it is developed further, they will be utilized many years ago for the manufac-

ture of lime.

The Brentwood limestone is very similar in its characteristics to the Pinck, but it is not so well exposed within the quadrangle and it is less numerous than that from the Pinck. It is also utilized for the manufac-

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"Nature and Soil."

Oil has recently been struck at Munger, Ind., and small amounts of gas have been obtained in the Fayetteville quadrangle. The stratigraphic and structural conditions in the Winlow quadrangle, although not so well developed, are in the northern part of the quadrangle, in the two anticlines already described. The portion of the northern of these two anticlines is the most favorably developed, forming a soil area extending 2 miles east of the Cincinnati quadrangle county line and from the western boundary of the quadrangle eastward for 10 Stop post-office. In the southern part of the northern the most favorable prospecting ground is in a small area lying between the Mountain Fork and Lee Creek and extending westward from a line a mile west of Natural Dam to the township line. In neither of these would it be worth while to drill more than a few feet below the base of the Boise formation.

Only hand.

The Idaho limestone is hard, being highly charged with silica. That from the Boise and Hale, while hard, contain a considerable amount of silica, and it is expected that if it is developed further, they will be utilized many years ago for the manufac-

ture of lime.

The water from these springs—about 1 mile northwest of Mount Union—there is a strong spring in sulphur, which has been inclosed and is locally used for medicinal purposes. But it has been inclosed and is locally used for medicinal purposes. But it has been inclosed and is locally used for medicinal purposes. But it has been inclosed and is locally used for medicinal purposes. But it has been inclosed and is locally used for medicinal purposes. But it has been inclosed and is locally used for medicinal purposes.