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THE BROWN IRON ORES OF THE WESTERN HIGHLAND RIM OF TENNESSEE[1]

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INTRODUCTION

The brown iron ores of the western Highland Rim of Tennessee have claimed the attention of geologists for nearly a century. Gerard Troost, the first State Geologist of Tennessee, from 1831 to 1850, mentioned the deposits at various times in his reports to the General Assembly of the State of Tennessee. James M. Safford, whose name will always be closely linked with the early knowledge of Tennessee geology, devoted considerable time to the mineral resources of the State, and gave special attention to the iron ores. It was he who first divided the State into four distinct iron ore producing belts, and in this classification included the ores of the western region. In Safford and Killebrew's *Introduction to the Resources of Tennessee,* which appeared in 1874, the western ore producing district received more than incidental mention.

Within the past twenty years these brown iron ores of the western Highland Rim have been the object of field work and investigation by several geologists, chief among whom are Purdue[2], Rogers[3], Drake[4], Miser[5], and Burchard[6]. Probably the most comprehensive discussion is that of E. F. Burchard of the United States Geological

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[1]Condensed revision of a thesis presented to the Department of Geology, Vanderbilt University, in partial fulfillment of the requirements for the degree of Master of Science. Read before the Tennessee Academy of Science at the Nashville meeting, November 27, 1931. Revised for publication.

[2]Purdue, A. H. 1912. *Iron Industry of Wayne and Lawrence Counties.* Resources of Tenn., Vol. 2, No. 10, pp. 370-388.

[3]Rogers, R. F. 1915. *Iron Ore Deposits of Lewis County.* Resources of Tenn., Vol. 5, No. 3, pp. 91-146.

[4]Drake, N. F. 1914. *Economic Geology of the Waynesboro Quadrangle.* Resources of Tenn., Vol. 4, No. 3, pp. 99-120.

[5]Miser, H. D. 1921. *Mineral Resources of the Waynesboro Quadrangle.* Tenn. Geol. Surv., Bull. 26.

[6]Burchard, E. F. 1927. *Brown Iron Ores of West-Middle Tennessee.* U. S. Geol. Surv., Bull. 795-D.

Survey in his *Brown Iron Ores of West-Middle Tennessee*. An even more detailed report by Burchard is at present in the hands of the Tennessee Geological Survey awaiting publication.

History of the Iron Industry in Western Tennessee

An investigation of old records indicates that the iron industry of the western Highland Rim had its beginning in the historic Cumberland Furnace locality in northern Dickson County. At this locality in 1797 it is reported that the first iron ore was dug, and the first iron was smelted, west of the Cumberland Mountains. The cannon balls used by General Andrew Jackson in the battle of New Orleans were made at Cumberland Furnace.

The writings of Troost and Safford indicate that the development of the iron industry in western Tennessee was rather slow during the first quarter of the nineteenth century. In 1831 there were only six blast furnaces in operation in the entire area. Four years later, in 1835, Troost lists twenty-seven.

It is interesting to note that most of the early development of the iron industry was limited to the northern counties, especially Stewart and Montgomery. A furnace was erected on Yellow Creek, in Montgomery County, in 1802. However, the southern part of the area did not lag far behind. In 1833 the old historic Wayne Furnace was built in northern Wayne County and was an important producer of pig iron until 1875. This furnace played an important role in the iron supply of the Confederates during the Civil War.

From the geological records of Troost the early furnaces of this region must have been of simple construction. Charcoal was the fuel used, and both hot and cold blasts were employed in smelting the ore. The brown iron ore was dug by hand methods in the open pits, and in most of the workings slave labor was used.

Shortly after the opening of the present century the iron industry of western Tennessee began to decline. The opening of new fields in the South, which produced a much higher grade of ore, offered competition which the mines of the Rim region were unable to meet. A glance into the publications of the *Mineral Resources of Tennessee* will immediately show that the ore production of this region has undergone a gradual, but steady, decrease since the beginning of the present century.

As an outgrowth of the iron industry two large by-product charcoal plants have been constructed in western Tennessee. These are located at Wrigley in Hickman County, and at Collinwood in Wayne County. In the plants the charcoal pig iron is in reality the by-product, since the more important products are wood alcohol, acetic acid and tar, made by the destructive distillation of hardwood. The plant at Collinwood, constructed during the World War at a cost of several million dollars, is now idle.

Topography of the Western Highland Rim

One of the most conspicuous features of the topography of Tennessee is the Central or Nashville Basin. It is an oval shaped depression located in the middle of the State, and surrounded on both the east and west by a belt of highlands, which was long ago very fittingly named the Highland Rim. The region that lies west of the Central Basin and east of Tennessee River is called the western Highland Rim of Tennessee, and contains approximately 5,500 square miles. It is roughly a north-south belt of highlands, extending north into Kentucky and south into Alabama. The width varies to some extent, but averages 40 to 50 miles. The counties usually considered as composing the western Highland Rim area are—beginning at the

Fig. 1. View of the western Highland Rim of Tennessee, near Iron City in Lawrence County. Note the even skyline in the distance.

northwest—Stewart, Montgomery, Houston, Dickson, Humphreys, Hickman, Perry, Lewis, eastern part of Hardin, Wayne, and Lawrence. It is with the brown iron ores of this physiographic division that the present paper is concerned.

The Cumberland and Tennessee rivers are the two master streams controlling the drainage of the western Highland Rim. The Cumberland enters the area from the east, while the Tennessee River has a general northward trend, and roughly marks the western boundary of the Highland Rim province. Duck and Buffalo rivers, which are tributaries of the Tennessee, are the chief streams in the central

part of the region. Other tributaries of the Tennessee River, viz., Shoal, Indian, and Hardin creeks, are important streams in the southern counties.

From a general topographic standpoint, the western Highland Rim is a highly dissected plateau, ranging in altitude from 600 to 700 feet to over 1,000 feet above sea level. The average altitude is probably 850-950 feet. The plateau has been cut into by numerous streams, which have formed many V-shaped valleys and left narrow ridges that rise from 250 to 300 feet above the streams. Erosion has formed a complex, radiating system of valleys. Spurs extend from the main dividing ridges of the Rim and are important in controlling the drainage of the secondary streams. Most of the ridges are narrow and winding and have flat-topped crests which are remarkably uniform in altitude, as is shown in any skyline view across the region (Fig. 1). Often the altitudes of some of these ridges vary less than 15 or 20 feet in several miles. This even skyline has given rise to the term "flatwoods" applied to relatively large areas of flat or gentle rolling uplands in the southern counties of the Rim.

The even skyline as seen from the top of practically any ridge in the western Highland Rim is suggestive of a peneplain. These flat-topped ridges represent remnants of what was once a continuous plain called the Highland Rim or Highland Plain. Throughout the Paleozoic era there were many submergences and elevations of the area now known as the Highland Rim. It has been suggested that the Paleozoic rocks were eroded down to nearly a common level during the late Paleozoic and early Mesozoic time. During Upper Cretaceous time a sea covered most the western Highland Rim and laid down deposits of gravel, sand, and clay, which are now represented by remnants of the Tuscaloosa gravel and the Eutaw sand, which cap some of the higher ridges. Following Upper Cretaceous time the land was slightly elevated, and with this elevation the processes of erosion began. By the end of the Eocene central Tennessee began to rise, but if there was lower Tertiary elevation in the western Highland Rim it was very slight. However, during the lower and middle Tertiary there was a definite peneplanation of the area, with the formation of nearly a flat plain. Then in late Tertiary time the region was again uplifted. A still more recent uplift began about the middle of the Pleistocene and it has been followed by the present day erosion.

Geology of the Western Highland Rim

STRATIGRAPHY

Rocks of sedimentary origin, ranging in age from Ordovician to Quaternary, form the surface of the western Highland Rim; most of the Rim being underlain by rocks of Mississippian age. Since the brown iron ores of this region are restricted in association to rocks of post-Devonian age, the Ordovician, Silurian, and Devonian formations will not be discussed any further than to mention that they

outcrop in some of the deeper stream valleys, especially in the southern counties of the region.

The following is a brief resume, in ascending stratigraphic order, of the post-Devonian formations of the western Highland Rim:

MISSISSIPPIAN SYSTEM

Waverlian Series

Chattanooga Shale. The Chattanooga shale is a fine, even textured, black carbonaceous shale, which splits readily into large flakes. It has not been observed in direct association with the iron ores.

New Providence Shale. The New Providence shale, formerly known as the Ridgetop shale, is a gray, platy, siliceous shale, glauconitic near the base. It may be locally calcareous, and reaches a maximum thickness of nearly 100 feet in the southern counties.

Fort Payne Chert. The Fort Payne formation is a gray, cherty, crinoidal limestone, calcareous chert, and gray shale. It is exposed on the hill slopes not far below the general upland level. It is very abundant in the region, varying in thickness from 100 to 200 feet.

Tennessean Series

Warsaw Formation. The Warsaw is a massive, cherty limestone with a few sandstone beds. It probably underlies most of the upland area south of Duck River. The Warsaw weathers to a deep-red clay, containing fragments of chert, and this residual clay often contains deposits of brown iron ore in the southern counties of the Rim.

St. Louis Limestone. The St. Louis limestone is represented in the western Highland Rim by a blue-gray, massive, cherty limestone, weathering to red clay and broken chert. It underlies a large part of the upland north of Cumberland River, and smaller areas south to Duck River. The red clay formed by the weathering of the St. Louis formation often contains deposits of brown iron ore.

CRETACEOUS SYSTEM

Upper Cretaceous Series

Tuscaloosa Formation. The Tuscaloosa formation consists of a gravel with variable quantities of clay and sand, and caps the higher ridges and hills in the southwest and northwest parts of the area. In certain localities the iron ore has cemented this gravel into a hard conglomerate (Fig. 2).

Eutaw Sand. The Eutaw sand is a red micaceous sand with some clay. It has been found only on the higher ridges in the southwest and northwest parts of the region.