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Part II.—COAL, LIGNITE, AND PEAT

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CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1906, PART II.

COAL, LIGNITE, AND PEAT.

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INTRODUCTION.

By MARIUS R. CAMPBELL.

NEED OF INVESTIGATION.

The constantly growing consumption of coal in the United States has led to the opening of mines in almost every State in the Union and it has also stimulated prospecting to a marked degree. This condition of affairs has created a strong demand for information concerning the extent of the coal fields, the geologic relation of the beds, and the quality of the coal. In the comparatively unknown coal fields of the West the demand is for general information regarding the extent, number, and thickness of the beds and the quality of the coal. In the better known fields the demand is for detailed information which will enable the prospective operator to know how much of any one coal bed is available, and how it lies, so that he may locate his mine in the best position for economic work.

In order to meet this growing demand the Geological Survey has been giving more and more attention to the subject of coal, both as regards its geologic relations and its technology. The need for information in both branches is imperative, for, although the amount of coal in the various fields seems so great as to be well-nigh inexhaustible, the consumption is increasing so rapidly that already the question of a future supply of fuel is a serious one and the Government is surely justified in using every means possible to conserve the supply for the

use of future generations. Accordingly the technologic branch of the Survey is engaged in studying the fuel problems in order to devise, if possible, less wasteful methods of mining and more economical methods of utilizing the coal after it is mined.

Our chief fuels are coal, oil, and wood. Wood already is almost a thing of the past; oil, although used extensively in some parts of the country for the production of power, is necessarily of limited occurrence and before long may cease to be an important factor in the problem. Coal, therefore, is the fuel of the present, and, so far as can be seen, will continue to lead in this particular for a long time to come.

The importance of the coal industry at the present time is well illustrated by a comparison of the values of the leading mineral products of the United States for the year 1905.

Values of six of the leading mineral products of the United States in 1905.[a]

Coal	$476,756,963
Iron	382,450,000
Clay products	149,687,188
Copper	139,795,716
Oil and gas	125,720,254
Gold and silver	122,402,683

So far as fuels are concerned the work of the Geological Survey may be divided into three classes—geologic, technologic, and statistical, the last of which is in charge of the division of mineral resources. The object of this report is to give, in a brief way, a synopsis of the results accomplished in the various branches of the work during the last year in advance of the more detailed reports covering the same subjects.

GEOLOGIC WORK.

All geologic work on the mineral fuels of the United States is under the general supervision of the writer. The work is of various grades and degrees of precision, depending on the needs of the public and the conditions under which the surveys are carried on.

In that part of the country west of the 100th meridian the coal fields are comparatively unknown, and the work of the Survey is largely exploratory. Rapid reconnaissance surveys are made over large areas to determine the limits of the field and to obtain such information regarding the number and character of the coal beds and their attitude as may be possible in the present undeveloped condition of the field and with the hasty method of examination. Where the outlines of the fields are already fairly well known the work is largely devoted to a more or less detailed investigation of the number and thickness of the coal beds, the quality of the coal, and the best locations for economical development of the field.

In the eastern fields information is needed almost as badly as in the West, but the work is of a much more detailed character and involves

[a] Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906.

not only a thorough study of the geologic conditions under which the coal occurs, but also a study of the quality of the coal and its adaptability to various commercial uses.

The reports here presented cover results obtained wholly or in part during 1906. Geologic work has been done in the various States as follows:

Pennsylvania.—Since 1900 the examination of the Pennsylvania coal field has been carried on through the cooperation of the State and Federal authorities, but the field work has been done entirely by the geologists of the United States Geological Survey. In this time very detailed surveys have been made of most of the Pittsburg coal region of the southwest corner of the State, of a large area in the eastern part of the bituminous coal field in Indiana, Cambria, and Clearfield counties, and of a part of the Allegheny Valley, embracing an area of about 5,000 square miles.

All coal work in this State is under the general direction of George H. Ashley, who was assisted during the past year by W. C. Phalen, Edwin F. Lines, M. J. Munn, and Frederick B. Peck. Surveys were carried on in Cambria, Clarion, and Allegheny counties, and some of the results are given in this volume in papers entitled "Coal in the Clarion quadrangle, Clarion County, Pa.," by E. F. Lines, and "The coal resources of Johnstown, Pa., and vicinity," by W. C. Phalen.

Virginia-Kentucky.—A reconnaissance survey was made of a district in the central part of the Appalachian field under the general supervision of George H. Ashley. The building of a new branch line from the Chesapeake and Ohio Railway up Russell Fork of Big Sandy River to the Virginia line and the beginning of construction of the South and Western Railroad from the end of this branch to the Atlantic coast promises to open in the near future one of the largest and best tracts of coal land in the central Appalachian region. In order to be able to furnish information on this interesting and economically important region, a detailed reconnaissance was made by Ralph W. Stone, assisted by C. W. Dodge, on both sides of the Virginia-Kentucky State line, and the more important results will be found in three papers in this bulletin by Mr. Stone entitled "The Elkhorn coal field, Kentucky," "Coal mining at Dante, Va.," and "The Russell Fork coal field, Virginia."

Alabama.—For several years Charles Butts has been engaged in a close, detailed survey of the coal fields in the vicinity of Birmingham, including much of the Warrior basin. During the past year Mr. Butts was assisted by Chester W. Washburne, and the work was carried to the east into the Cahaba coal field. Time did not permit the survey of the entire field, but the northern part was examined thoroughly, and a brief account of the results of this work may be found in a paper by Mr. Butts entitled "The northern part of the Cahaba coal field, Alabama."

Illinois.—In Illinois the examination of the coal field is carried on both by the State Geological Survey and by the Federal organization, with the understanding that each shall supply to the other manuscript reports on the area or areas investigated. During the last year the work of the Federal Survey was confined to two 15-minute quadrangles in Gallatin, Saline, White, and Hamilton counties, and the results are embodied in a paper in this volume by Frank W. De Wolf entitled "Coal investigations in the Saline-Gallatin field, Illinois."

Arkansas.—A demand for more detailed information regarding the Carboniferous coal field of Arkansas than is contained in the reports of the State Geological Survey led the Federal organization to make an examination of this field in the early part of the past summer. The work was done by Arthur J. Collier, assisted by Carl D. Smith, Sidney Paige, and R. D. Mesler. This work is of especial value, inasmuch as it has established the identity of the principal coal beds at the east and west ends of the field, and has thrown considerable light on the distribution of the workable coals, a point that has been troubling the operators for a number of years. A brief account of this work is given by Mr. Collier in a paper entitled "The Arkansas coal field."

Montana.—The coal fields of Montana are probably more extensive than those of any other State, but they are not well known except along the main lines of railroad where mines have been opened, either to supply fuel for locomotive use or for the great copper smelters of the Butte region. The quality of the Montana coal is exceedingly varied, but as a rule only the better grades are being mined at the present time.

The most important piece of geologic work carried on in Montana during 1906 was the careful mapping of the Great Falls coal field by C. A. Fisher, assisted by W. R. Calvert, H. M. Eakin, A. J. Hazlewood, and J. D. Pollock. Geologically this field is most interesting, since the coal occurs in the Kootenai (Lower Cretaceous) formation, which is not known to carry coal in any other part of the United States, except possibly in the Black Hills region of South Dakota and Wyoming. The field was carefully mapped from Missouri River eastward along the foothills of the Little Belt Mountains as far as Stanford. A brief synopsis of the results is given in a paper by Mr. Fisher entitled "The Great Falls coal field, Montana."

The Bear Creek and Red Lodge fields of Carbon County were examined by N. H. Darton, who traced the Red Lodge group of coal beds for a considerable distance to the point where they are concealed by the overlying Tertiary rocks, and the Bridger coal bed from a point near the Wyoming line northward to Joliet. An account of this field by Mr. Darton is entitled "Coals of Carbon County, Mont."

The great lignite field of the eastern part of the State was examined by A. G. Leonard, assisted by W. R. Holgate and W. H. Clark.

This party made an exploratory trip from Glendive to Miles City and thence northward by way of Jordan to Hell Creek on Missouri River. An account of this trip and of the coal beds and other strata exposed will be found in a paper by Mr. Leonard entitled "Coal fields of parts of Dawson, Rosebud, and Custer counties, Mont."

Wyoming.—Wyoming is one of the great coal-producing States of the Union. The coal is extensively developed along the Union Pacific and Oregon Short Line railroads at Hanna, Rock Springs, and Kemmerer. It is also mined to some extent at Glenrock and Big Muddy on the Chicago and Northwestern Railway and along the Burlington system at Sheridan and Cambria. In addition to these well-known localities, there are immense areas of coal land along Powder River from a point north of Casper to the Montana line, in the Bighorn Basin, in Uinta County north of Kemmerer, and in Carbon County west of Rawlins.

During the past year the Hanna field of Carbon County was rather thoroughly explored by A. C. Veatch, assisted by Max A. Pishel, Max W. Ball, and Spencer R. Logan. A brief account of this work is given by Mr. Veatch in a paper entitled "Coal fields of east-central Carbon County, Wyo."

C. E. Siebenthal made a hasty examination of the coal beds in the western part of the Laramie basin, and a brief account is given by him in a paper entitled "Coal of Laramie Basin, Wyoming."

During 1905 A. C. Veatch, assisted by A. R. Schultz, made an examination of the southern Uinta County field from the Utah State line to a point north of Kemmerer. A short account of this work appeared in Bulletin No. 285, and a full report is contained in Professional Paper No. 56, entitled "Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil." During the past year this work was carried northward by Mr. Schultz, assisted by E. Eggleston Smith. The country is exceedingly rough and mountainous, but the coal fields were mapped with considerable care as far as Snake River. This region is scarcely accessible at the present time and little is known regarding the coals, but in the event of the construction of a railroad line along Snake River it seems quite possible that much of the area of this field would become accessible by branch lines from the main trunk system. A brief account of this field will be found in a paper by Mr. Schultz entitled "Coal fields in a portion of central Uinta County, Wyo."

In the central part of the State there is a large syncline of coal-bearing rocks which in most places is covered by Tertiary sediments to such a depth that it is not accessible, but here and there along the rim of the basin coal beds are exposed. This is the case in the vicinity of Lander, where there is a small coal field that was examined by E. G. Woodruff. A very brief account of this field is given by Mr. Woodruff in a paper entitled "The Lander coal field, Wyoming."

Colorado.—Through the explorations carried on by the Colorado Fuel and Iron Company and the development of mines in the best and most accessible fields, the coals of Colorado are perhaps better known than those of any other western State. Nevertheless, there are a number of areas about which little information can be obtained, and it has been the aim of the Geological Survey to explore these in advance of development.

The largest area of undeveloped coal lies in the northwestern part of the State, in Routt, Rio Blanco, Garfield, Pitkin, and Mesa counties. On the completion of the Denver and Northwestern (Moffitt) Railroad through Routt County the northern part of this great area, or the Yampa coal field, will be the first to be developed. This was examined in 1905 by N. M. Fenneman and Hoyt S. Gale, and a detailed report of their work appeared in Bulletin No. 297, entitled "The Yampa coal field, Routt County, Colo." A brief account was published also under the same title in Bulletin No. 285. During the last season this survey was extended southward across the anticline of Axial Basin to the Danforth Hills and thence along the Grand Hogback southeastward to Newcastle on Grand River. This work was done by Mr. Gale, who was assisted by A. K. Adams, A. L. Beekly, and R. D. Crawford. A brief account of this work is given by Mr. Gale in a paper entitled "Coal fields of the Danforth Hills and Grand Hogback in northwestern Colorado."

Colorado-Utah.—The great Uinta Basin, which extends from the vicinity of Crested Butte, Colo., westward into Utah, continues in the latter State along the south side of the Uinta Mountains at least as far as Castle Gate. The center of the basin is deeply covered by Tertiary sediments, and at the western extremity these overlap the upturned edges of the coal-bearing rocks and conceal them so that the limit of the field in this direction is unknown.

It is generally understood that the Book Cliffs, which form the southern margin of this basin, are coal bearing, but little or no information outside of that furnished by the established mines has been available regarding the character of the coal or the number and thickness of the beds. To supply such data George B. Richardson, assisted by W. D. Neal and Leon J. Pepperberg, carried on a rapid reconnaissance during the last season from De Beque, on Grand River, Colorado, into Utah as far as the Sunnyside mine of the Utah Fuel Company, where connection was made with the work of Mr. Taff, who, during 1905, made a careful instrumental survey of the Book Cliffs field from the Sunnyside mine westward to Castle Gate, and then southward along the east front of the Wasatch Plateau as far as Mount Hilgard, in Sevier County. A report of Mr. Taff's work was published in Bulletin No. 285 under the title "The Book Cliffs coal field of Utah." A brief account of the results of the survey during

the last year is given by Mr. Richardson in this volume in a paper entitled "The Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah."

Utah.—During the last year Joseph A. Taff, assisted by Carl D. Smith, examined the region about Pleasant Valley, in the Wasatch Plateau, much more carefully than was possible during the previous year, and his report is embodied in a paper entitled "The Pleasant Valley coal district, Carbon and Emery counties, Utah."

The coal fields of Iron County, in southwestern Utah, were hurriedly examined during the last year by Willis T. Lee, who visited them and procured samples for chemical analysis from the anthracite of the western extremity of the field and from the bituminous coal east of Cedar City. This is the most important field of the Southwest, as it is accessible from the San Pedro, Los Angeles and Salt Lake Railroad, and some day it may furnish fuel to most, if not all, of the desert region of the southern part of the Great Basin. A brief description of the field will be found in a paper by Mr. Lee entitled "The Iron County coal field, Utah."

New Mexico.—The largest coal field in New Mexico lies in the northwest corner of the Territory, but the coals in this field are not well known, being developed only at Durango, Colo., and Monero, N. Mex., on the northern edge, and at Gallup, on the southern edge of the basin. In Contributions to Economic Geology for 1905 F. C. Schrader [a] had a brief paper embodying the results of a rapid reconnaissance examination made by himself and M. K. Shaler along the eastern edge of the basin from Durango to Gallup. During the last year the work has been continued by Mr. Shaler, assisted by James H. Gardner. They made a careful examination of the western part of the field from Durango to the southern point of the basin, about 60 miles south of Gallup. The results of this work are contained in a paper by Mr. Shaler entitled "A reconnaissance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico."

In addition to the regular work noted above, the writer made a hasty examination of two small coal fields in the eastern part of the Territory—one at Capitan, in Lincoln County, and the other known generally as the Una del Gato field, in Sandoval County. A brief account of the latter is contained in a paper entitled "The Una del Gato coal field of Sandoval County, N. Mex.," and of the former in a paper entitled "Coal in the vicinity of Fort Stanton Reservation, Lincoln County, N. Mex."

California.—In general the coals of California are of so low a grade as to be unable to stand in competition with fuel oil. As a consequence many of the mines have suspended operations. From time

[a] The Durango-Gallup coal field of Colorado and New Mexico; Bull. U. S. Geol. Survey, No. 285, 1906, pp. 241-258.

to time during the last few years reports have been made of the occurrence of a better grade of coal in Stone Canyon, in the southeastern part of Monterey County. In 1905 Ralph Arnold visited Stone Canyon and determined the geologic relations of this coal bed. A brief account of his work appeared in Bulletin No. 285, entitled "Coal in the Mount Diablo Range, Monterey County, Cal." During the past summer the writer found opportunity to visit this mine, and a short account of the results of the examination, as well as of those obtained from a chemical analysis, is contained in a paper entitled "Coal of Stone Canyon, Monterey County, Cal."

TECHNOLOGIC WORK.

The technologic work on fuels is under the direction of Joseph A. Holmes. Up to the spring of 1907 the work of this branch has been carried on largely at St. Louis, Mo., where it was started in connection with the exposition in 1904. The principal work of the branch has been the testing of carload samples of coal, and in order to do this systematically it was necessary for an inspector to supervise the loading of cars, and as a check to take samples from the mine furnishing the carload lot. During the last year this work has been under the charge of J. Shober Burrows, who has made an extended study of methods of sampling and the results to be obtained therefrom. A brief account of these results and a discussion of their meaning is given by Mr. Burrows in a paper entitled "The importance of uniform and systematic coal-mine sampling."

One of the most important results of the various tests for the better utilization of the fuel resources of the country is the demonstration that producer gas for power purposes can be made successfully from all grades of bituminous coal, lignite, and even peat. The results of these tests point conclusively to the substitution of producer-gas plants and gas engines for the generation of power in place of the wasteful steam engine in general use at the present time. The end of the steam engine is nearly in sight, and many people are wanting information regarding the present status of the producer and gas engine, in expectation of their installation in the near future. In order to supply unbiased information to the public on this important subject, R. L. Fernald, professor of mechanical engineering, Washington University, St. Louis, Mo., who has had charge of all tests made at the fuel-testing plant on the gas producer and gas engine, has prepared a brief statement which will be found in a paper entitled "The present status of the producer-gas power plant in the United States."

Another field of investigation which promises to have a distinct bearing on the better utilization of our coals is that of briquetting, and the present condition of the briquetting industry is summarized by Edward W. Parker in a paper entitled "Condition of the coal-briquetting industry of the United States."