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DEPARTMENT OF AGRICULTURE, INSURANCE, STATISTICS AND HISTORY,
GEOLOGICAL SURVEY OF TEXAS.

JON E. HOLLINGSWORTH, Commissioner. E. T. DUMBLE, State Geologist.

PRELIMINARY REPORT

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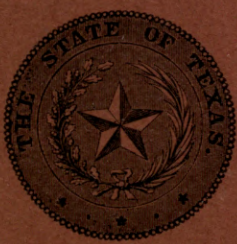
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UTILIZATION OF LIGNITE,

BY

E. T. DUMBLE.

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PRELIMINARY REPORT ON THE UTILIZATION OF LIGNITES.

E. T. DUMBLE, STATE GEOLOGIST.

Hon. John E. Hollingsworth, Commissioner of Agriculture, Insurance, Statistics and History:

SIR—In accordance with your instructions, under an act of the Legislature directing an investigation into the methods of using lignite in Europe, I visited the principal deposits of browncoals in Germany and Austria, compared the different varieties with those of Texas, and examined the various methods of utilizing them.

While the limited time which I could give to this investigation prevented my visiting the deposits of France and Italy, the results are so satisfactory, full and conclusive, that an inspection of these localities was not absolutely necessary, although it would doubtless have been instructive in many ways.

Throughout my entire trip I met with the kindest attention and with the most ready and valuable assistance from the geologists and mining officers, both public and private; and it was only through the opportunities thus afforded that I was enabled, in the time at my disposal, to cover so much ground and gather the necessary information. In the following report, which must be regarded as merely preliminary, I have summarized the results of my investigations. As soon as I can prepare it, a full report will be made which will contain many details, references and descriptions which cannot be included here.

EUROPEAN BROWNSOAL.

The browncoal of Europe may be divided into four general classes, viz.: 1, Lignite; 2, Common Browncoal; 3, Pech Coal; 4, Glance Coal—all of which have representatives in Texas.

LIGNITE.

In Germany and Austria this term is only used to designate such fossil fuel as fully retains its woody character and fiber. It is usually found accompanying other varieties of browncoal, and consists of those fragments of the original woody material from which the beds were formed that have escaped maceration and decomposition. In some places, however, when conditions were favorable to its preservation it forms the main body of the deposit. Sometimes it occurs surrounded by earthy browncoal, and often has particles of fatty browncoal or jet inclosed with it, following the rings of growth. Much of it as it comes

from the mine retains its form and character so completely as to be almost indistinguishable from the ordinary wood of the present time, except that it is somewhat darker in color.

COMMON BROWNCOAL.

This name covers a number of varieties, varying in color from yellow to brownish black, and from those having a specific gravity less than water to those of 1.2 and 1.3. Their common qualities are their large percentage of water and their earthy, friable nature. The two most important of these varieties are "Schweelkohl" and Earthy Brown-coal.

SCHWEELE COAL.—This variety, in its purest form, resembles a yellow clay much more closely than it does coal. Its composition and character, as revealed by chemical analysis and the microscope, vary somewhat from the other browncoals, and it is the variety which has the least specific gravity. It is the richest in tarry matter, and is therefore especially desirable for the manufacture of paraffine and oils. It occurs most frequently with earthy browncoal and often in alternating layers with that variety.

EARTHY BROWNCOAL.—This variety of browncoal is, as its name indicates, of an earthy character, brown to brownish black in color, in its ordinary condition containing as much as forty-five or even fifty per cent of moisture. While it somewhat resembles our Texas brown-coal, especially in the fatty streaks which occur in it, the German is much more friable than ours and also much inferior to it in heating value in the raw state on account of the great percentage of water it contains. This is the character of browncoal that is found most largely developed in the district around Halle, a. S., and in the Rhine provinces. Much of it lies very near the surface, in beds varying from a few inches to sixty feet in thickness, and is most often mixed with Schweel coal to a greater or less extent. From this variety of brown-coal is manufactured the "nass-press-stein" and browncoal briquettes without bond.

PECH COAL.

A darker and firmer variety of browncoal, which contains a smaller amount of water, and which often closely resembles pitch both in color and fracture, is called Pech coal. The coal of the Bohemian basins is very largely a mixture of common browncoal (of somewhat drier nature than the German) and Pech coal, together with some lignite, and is the equivalent of the larger part of our Texas deposits.

GLANCE COAL.

This is the finest variety of lignitic or browncoal, in certain instances passing into jet. It occurs principally in Styria with other varieties of browncoal, although smaller quantities occur in many localities.

These varieties are again subdivided into minor divisions, and they pass by insensible gradations one into the other, frequently in one and the same bed.

STATISTICS.

The following statistics, taken from the government reports of the

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empires of Germany and Austria, show to what extent these brown-coals were used during the year 1890:

	Tons mined.	Value at mine.
Germany.....	15,468,434	\$9,967,812 00
Austria.....	15,329,056	12,482,603 00
Total.....	30,697,490	\$22,450,415 00
Of which—		
Rhine Provinces.....	661,590	\$381,139 00
Halle, a. S.....	14,077,382	9,031,238 00
Styria.....	2,270,023	2,942,327 00
Bohemia.....	12,190,932	8,240,780 00

This amount, over three hundred thousand car loads, is nearly thirty per cent of the entire coal (stone coal and browncoal) production of these empires, which was (for 1890) 104,702,370 tons. Of the total amount of browncoal mined, the district around Halle, Germany, and Bohemia and Styria, in Austria, produced eighty per cent.

The amount of browncoal used in the manufacture of briquettes, coal bricks, tar, paraffine, etc., during the year was a little less than seven million tons, and the remainder—over twenty-three million tons—was used "raw," or just as it came from the mine, without preparation of any kind.

USES OF EUROPEAN BROWNCOAL.

As has already been stated in our circular No. 8 and in the various reports of this Survey, the uses of browncoal are as varied, general and important as those of stone coal. The results of my personal investigations not only fully confirm the statements made heretofore by myself and other members of the Survey, in regard to the availability of the Texas browncoal for fuel purposes, but add greatly to them.

LIGNITE.

When lignite is found in sufficient quantity, it is charred in meilers, kilns or retorts, in the same manner as ordinary wood, and yields a charcoal of similar quality and equally suitable for all fuel purposes. Thus, in lower Styria, where it occurs in great quantities as a part of a browncoal deposit, having a total thickness of over three hundred feet, it is charred in ovens arranged for the recovery of the by-products as well as the charcoal. The charcoal made here is used in iron smelting.

Where the lignite occurs in smaller quantities, as in the province of Saxony and on the Rhine, it is used with the browncoals under steam boilers and for various other fuel purposes.

COMMON BROWNCOAL.

The Schweetcoal, as has already been stated, contains large amounts of tarry matter, and for this reason is especially desired by the Schweeteries or factories which manufacture from it the tar and its derivatives, paraffine and oils of various grades. These oils vary in quality from one especially adapted for the manufacture of gas for lighting purposes, through heavy and light oils to a solar oil about equivalent to

our best refined petroleum. While the introduction of American and Russian petroleum into Germany has in some measure checked the working of the Schweeleries for oil purposes, the demand for paraffine is so great as to keep the factories still at full work. This industry, as shown by the statistics given, is one of great importance to these districts of Germany, amounting as it does to over four millions of dollars annually and giving employment to several thousand men. The records of the German Browncoal Association show that in the year 1890 the amount of browncoal used by the companies belonging to the association for the manufacture of tar and paraffine was over twenty millions hectolitres, and the value of the product seventeen million one hundred and twenty thousand marks (\$4,280,000.) The coke made from the Schweelcoals by this process is called "grude coke," and experience has proved it to be such an excellent fuel for household purposes that the demand is in excess of the supply. It is used in stoves of special construction for cooking and heating. It is of too fine a grain and not compact enough to be of any use in smelting iron.

The earthy browncoal is used "raw," or as it is mined, for household, manufacturing, or steam purposes, and is also manufactured into nass-press-stein and briquettes.

Nass-press-stein, or coal bricks, are made by mixing the browncoal with water until it is of a putty like consistency, compressing by machinery similar to that used in making pressed brick, and then drying these brick in the air. While the amount of this fuel is small in comparison with that of briquettes made by the dry method, it is nevertheless a useful and serviceable fuel for household purposes.

Dry briquettes, made from this variety of browncoal, are in great demand, and the output is increasing yearly. The process of manufacture consists of drying the browncoal by one of the several methods until the water contained in it is reduced to a certain percentage and then compressing it under a pressure equal to that of fifteen hundred to two thousand atmospheres. The resulting briquette is of a lozenge or elliptical shape, some six inches in length and about one inch in thickness, very firm and durable. The compression is so perfect that the briquette will not absorb water even if it be laid in it for some time. The earthy browncoal is preferred for briquette making on account of the ease with which it is pulverized.

In a raw state browncoal is also used for burning bricks, stoneware, and drain tile, for which purposes it is preferred to any other fuel. Brick clays and fire clays are often found in close proximity to the browncoal, and the manufacture of bricks, fire brick and tiles, at an extremely low price, is thus rendered practicable, and a great number of mines have brick yards in connection with them by means of which they are enabled to make use of all their coal, even what would otherwise be refuse.

At one of the larger brick works on the Rhine the experience of several years trial proved that a firing with a mixture of browncoal briquettes and raw browncoal gave better results in actual work than stone coal alone, stone coal with briquettes, or stone coal and raw browncoal, and at the time of my visit works were just being completed for briquetting their browncoal for use in this manner.

In using this earthy browncoal for such firing purposes, or under steam boilers and elsewhere, due attention is given to the arrangement of the fire-boxes and grates to suit the fuel. If a flat grate is used the

grate bars are made very narrow and with small intervals between each. The favorite grate, however, is called the "treppen rost," and is a grate arranged in a series of steps by which the air gets proper access to the browncoal without need of a blast sufficient to carry away the smaller particles unburned.

For household purposes stoves of suitable construction for cooking and heating, using raw browncoal or briquettes as fuel, are for sale everywhere in Germany. The briquettes are preferred for fuel on account of their cleanliness and freedom from smoke in burning.

The comparative extent of the use of the various fuels in the ordinary way may be seen from the statistics of the fuel supply of the City of Berlin for the year 1890, taken from the annual report of the Kohlenzeitung:

Stone coal, coke, etc.....		1,755,383 tons.
Bohemian browncoal.....	242,027 tons.	
German browncoal briquettes.....	577,674 tons.	
German browncoal.....	21,534 tons.	
Total browncoal.....		841,235 tons.

or about thirty-one per cent of the entire fuel supply.

A great many tests have been made to determine the ratio of fuel value of the German browncoal and stone coal. The results give the ratio between the Westphalian coal and earthy browncoal and briquettes about the following relation in amounts required to produce the same amount of steam:

Westphalian Coal.	German Browncoal.	Briquettes.
1.	2 to 2½	1¼ to 1½

The Bohemian browncoal contains less moisture than the common browncoal of Germany, and is therefore a better fuel in its raw state. Throughout Bohemia it is put to every use—domestic, manufacturing or metallurgical—for which stone coal is used, except the smelting of iron ores and production of pig iron. The locomotives, which have very heavy work over the mountain railways, use it exclusively. Brick works, chemical works, glass factories, firebrick and tile works, potteries, cement factories and limekilns are all run successfully and economically with this browncoal as their only fuel. It is used as fuel *exclusively* by the largest iron and steel works of the country for the processes of converting pig iron into wrought iron and steel and for rolling this into rails, bars, wire, sheet iron and all similar products.

The use of this fuel in this manner was made possible by a close technical study of its character and a practical application of the results to manufacturing purposes. The construction of the fireboxes and grates is such that the necessary conditions to its best utilization are fulfilled, and when high heats are wanted for smelting iron or heating ingots, as in the manufacture of wrought iron and steel and in rolling mill work generally, gas firing is resorted to.

This kind of firing, which is the one most generally in use with the browncoal for all purposes where the higher temperatures are required, has several different methods of application, varying with the purpose for which the heat is required, but all having the same general principle at the foundation.

The browncoal is first converted into gas by burning in a producer of some description, usually a rectangular firebox with treppen rost

grate, fed from above. The gases produced in burning are carried off by proper conduits, the tarry matters separated, in part at least, by passing through an hydraulic main, and the remaining fixed gases pass either directly to the furnace or more often through a Siemens regenerative furnace to the place where they are burned. Here they are mixed with heated air and the heat produced by the combustion is ample for any and all purposes for which it may be required. The Bohemian browncoal has also been successfully briquetted after the German or dry method, already mentioned, and a factory has been in operation for several years at Koenigsberg, near Carlsbad.

This coal has also been coked by several methods, but up to the present time the coke has not been brought into use as fuel. In some places this was prevented by the character of the coke itself, which was unsuited for blast furnace purposes. In other cases, when the coke was suitable for such use, the cost of producing it was so great that it could not successfully compete with the cheap Silesian coke from stone coal.

In Styria there is found a still drier browncoal which in places very closely resembles jet. It is probably the equivalent of our Laredo coal, except that it contains very much less ash. This browncoal is of excellent quality, and has also been coked by methods similar to those used with the Bohemian, but the coke is not in use at present for the same reasons given above. It has, however, been found not only practicable but economical to use *thirty per cent and upward of this raw coal* in connection with coke from stone coal in the blast furnace for smelting iron ore and there are iron furnaces which have been in operation for years using this character of fuel.

This browncoal, mixed with a lignitic coal, is used in the same vicinity for rolling mills, steel and wrought iron production, etc. The browncoal of Bohemia and Styria is also used in the manufacture of gas for lighting purposes. It is distilled in retorts of the usual form and the operation differs in nowise from that with ordinary bituminous coal, except that the heated air from the furnace is used to evaporate the surplus moisture from the raw browncoal before it is put in the retort. The gas coke made from the browncoal in Bohemia is sold for use in the zinc works.

In Styria a browncoal similar to that of Texas is briquetted with a bond of stone coal pitch. Only the smalls are used, because there is usually a demand for all the lump coal that can be mined throughout this whole region and the briquette industry is therefore not needed. The briquettes are, notwithstanding, sold at a price fully equal to that of stone coal. The system used is the Coufinhal, and the briquettes are like those now in the Museum of the Survey, which were made during my earlier experiments.

From these facts it will be seen that the browncoals of Germany and Austria are not only adapted for use as fuel for all purposes, but that they are so used, and used successfully. Moreover, the statistics show conclusively that the browncoal industry of Germany and Austria is one of very great magnitude, and it will be shown by a comparison of statistics for twenty or thirty years past that the increase in the production of browncoal has kept fully abreast of that of stone coal.

COMPARISON OF EUROPEAN AND TEXAS LIGNITES.

As stated in the beginning of this report, I have compared our Texas lignites with those of Germany and Austria, and find that we have representatives of the various classes mentioned. I have personally examined the various classes of browncoal as they occur in the deposits, as they come from the mine, and as they are used in their various applications, and I have compared them with our Texas lignites, both in their physical character and chemical composition, with the result as stated. I have submitted average specimens of our Texas browncoals to the highest authorities on this subject in Germany and Austria, and they, without exception, confirm my statement, and unite in pronouncing the Texas browncoals of excellent quality, fully equal to the Bohemian, and equally suitable for use for all domestic, industrial and metallurgical purposes. I have therefore the pleasure of reiterating the statement made several times already, and each time supported by stronger evidence, that Texas has in the immense deposits of browncoal a cheap fuel which can be used for every purpose for which fuel is needed.

It should, however, be plainly understood in the beginning, that the browncoals of Texas will be found to differ very widely in quality, and it will require analyses of each deposit to tell with certainty for what purpose it is best adapted. Deposits will be found containing too large a percentage of ash, and some perhaps too large a percentage of sulphur, to be of value as fuel, although other uses may be found for them. Those that are suited for briquetting without bond may not serve equally well for other purposes, and some of the varieties of browncoal will not form a briquette at all by the dry method.

It is impossible, with detached basins of browncoal, formed under somewhat diverse conditions and stretching across an area seven hundred miles in length, that all should be equally good. That there is an abundance of the material that is of a most excellent quality is shown by the examinations and analyses already made by the Survey of deposits and specimens from all portions of the lignite belt, and yet other of these analyses also prove the existence of deposits which are comparatively worthless.

Therefore, in any undertaking having browncoal as its basis of supply, either as fuel or raw material for manufacturing purposes, an accurate knowledge of the material should be obtained before operations are begun.

UTILIZATION OF TEXAS BROWNCOAL.

The fact of the great fuel value of the browncoal having been thus fully decided, I have endeavored to secure all possible information, and when practicable the detailed drawings or plans of the various kinds of ovens, fireboxes, grates and appliances for using browncoal. Some of these are the subjects of patents, and can therefore only be used under royalty or purchase; others, and some of these the most important, are not patented and are free to all.

Through the kindness of the owners of the iron works and rolling mills in Bohemia and Styria, I have secured plans in detail of the fireboxes, gas producers, and arrangements by means of which they use the raw browncoal for the purposes stated. I have also the plan of the

blast furnaces which are now in operation using a mixed fuel of coke and raw browncoal.

From the manufacturers of locomotives I will have detailed plans of the fireboxes used on such locomotives as are intended for browncoal. All of these plans and methods are applicable for the use of our Texas browncoal for similar purposes.

The machinery for the production of briquettes by the dry method is manufactured in Germany, the most of it under patents. General descriptions and estimates of the cost of erection are in the office.

Presses and machinery for the production of briquettes using pitch as a bond are manufactured in Germany, France and England. I have plans and estimates of the different styles and sizes of these showing approximate cost of erection and operation.

Plants for the production of tar, paraffine, oils, etc., from the browncoals are of a much more complex nature. General plans and estimates are now in the office, and details will be furnished me as soon as they can be prepared.

Some of the principal uses of our browncoal will undoubtedly be in the manufacture of brick, firebrick, drain tile, paving tile, stoneware, pottery, glassware, cement and lime. Plans for the construction of ovens especially designed for these purposes and in successful use in Germany with browncoal firing are also being prepared.

All of these are at the service of those interested in the subject.

It can be stated now from experiments and analyses already made, both by private individuals and by the Survey, that we know that we have in the Texas browncoals certain varieties that are rich in tarry matter which will serve as a source of paraffine, and that some varieties can be briquetted with pitch as a bond and others by the dry method.

Special examinations and tests of our Texas browncoal by the largest browncoal manufacturing establishment in Europe, by the various methods of briquette manufacture in Germany and France, and by other specialists are now in progress, and as soon as their final reports are received the results will be published, together with the details of the various plants, estimates of the cost of erection, operation, etc.

AUSTIN, TEXAS, November, 18, 1891.

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