Mineral Industries

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SOME RECENT TRENDS IN COAL RESEARCH

PART II.

BY WALTER FUCHS, PH.D.

The question may now be raised: what about the origin of bituminous coals which are more important for most countries than the brown coals. The study of bituminous coals was begun late in 1930, was interrupted early in 1931, resumed in 1932 and again interrupted in 1933. However, certain definite results have been obtained which may be presented here for consideration.

It is generally known that a gap exists between brown coals and bituminous coals; the latter have, as a rule, a higher carbon content and are able to form coke, while the brown coals have a lower carbon content and on heating yield sandy residues. In 1932 a study was made of a type of coal which had been formed during the chalk period and may be regarded, according to the results obtained, as a type of a missing link between brown coals and bituminous coals. The first report on this problem was published in 1933 under the title: "Ueber die Aachener Kreidekohlen",[1] namely the coals from the chalk of Aix-la-Chapelle. These coals have apparently originated from wood and still show a woody structure on the outside. They form single slightly polished pieces of various sizes. When freshly found they are brownish black, and rather soft; when exposed to the air, they become deep black and glossy similar to vitrites. They might be regarded as Xylites and the geologists consulted called them asphalt-like Xylites. They are, however, much older than any type of Xylites dealt with hitherto; furthermore on microscopical examination they reveal cell lumina which are perfectly filled with a glassy homogeneous substance. (Figure V.)

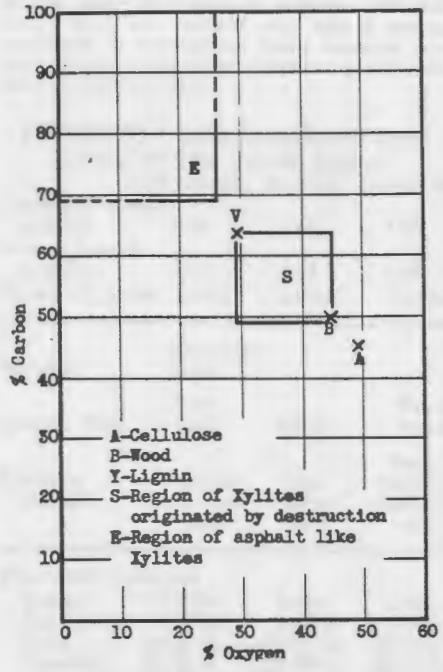

FIGURE IV

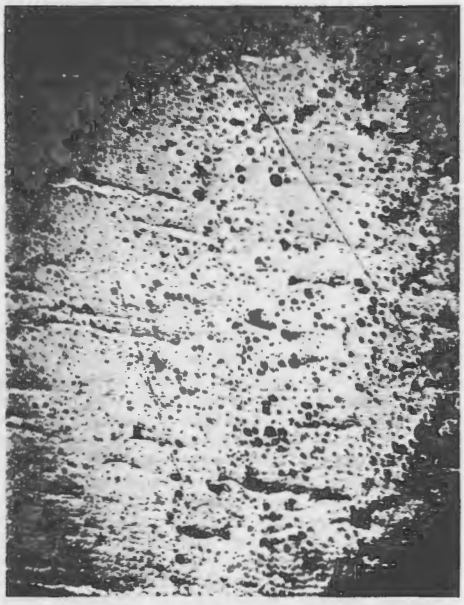

FIGURE V

The pieces of coal thus examined were found during the canalization of the streets of Aix-la-Chapelle. However, the geologists Dannenberg and Breddin of Aix-la-Chapelle assert that such formations are found all around the city in the deepest layers of the sand formed during the chalk period. These layers of sand belong to the Senon and are typical lagoon formations. Aix-la-Chapelle is surrounded by a narrow belt which contains the sand layers with the asphalt-like Xylites.

According to Dannenberg and Breddin these Xylites are characteristic of the older sand layers of the chalk surrounding Aix-la-Chapelle; furthermore the geologists assert that the coals beyong to the formation itself and are of the same age. On examining these very dense black pieces one might believe that they had been exposed to heat or pressure. It is, therefore, important to be able to exclude the assumption for the Xylites of Aix-la-Chapelle. According to geological evidence these pieces were produced under geological conditions somewhat similar to the common Xylites; namely, they never underwent dynamic action, never had a cover at the most of more than some hundred meters of sand and never attained a temperature of more than 30°-40°C. (86°-104°F).

A paleobotanical examination of this material was made by Professor Gothan. The wood was found to belong to a coniferae of the type of Dadoxilon or Araucarioxylon. The anatomical structure of the material corresponds with present day Araucariaceae, but shows as mentioned above, almost completely filled-in cells.

The preliminary report concerning this coal contains the results of the geological, botanical and chemical examination. This coal has a relatively high specific gravity. The carbon content is about 70%. Perhaps the most interesting feature is that on proximate analysis a coke is formed. According to these results this coal belongs with a group of gas flame coals or even fat coals. On the other hand, it is apparently derived from wood. It has 2.3% methoxyl and about 9% hydroxyl. Finally it contains nearly 3% sulphur; because of the low ash content of this coal, the sulphur must be present largely in organic combinations.

The chemical examination and botanical evidence clearly show that vascular plants offered a raw material for the formation of these coals. On the other hand, the asphalt-like Xylites do not fit in the area, which according to Figure IV, confines the Xylites originating by a pure process of decomposition of cellulose; furthermore they have a specific gravity unusual for Xylites and show perfectly filled cells. All this points to the fact that besides vascular plants, another source of raw material had to cooperate in the formation of these coals. One is compelled to conclude that the second source of material is a result of microbial action actually consisting of the cell substance of micro-organisms. This synthesized substance must have combined with the products of destruction thus affording a peculiar character to the humic part of the particular coal.

Several investigators considered the possibility that the special properties of bituminous coals are due to an inter-action between cell wall constituents and other substances. Stadnikoff pointed to unsaturated fats. Terres emphasized the importance of proteins in the process of formation of bituminous coals. Waksman demonstrated some interesting combinations between lignin and proteins which he regarded as very important in the formation of humus in soils and in composts. I may venture the opinion that it was the proteins of the microbes which played an important role in the formation of the asphalt-like Xylites under discussion.

Professor Gothan called my attention to some other coals closely related to the Xylites of Aix-la-Chapelle, namely the coals of Steyeregg-Wies in the Styrian district of Austria and the coal of Lowenberg in lower Eilesia. The latter, especially, is found under circumstances very similar to those established for the Xylites of Aix-la-Chapelle.

(Continued on page two)

Mineral Industries

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Dedicated to the exploration, development, and conservation of Pennsylvania's natural mineral resources, and their preparation, processing, and efficient utilization.

FIELD OF WORK

Geology, Mineralogy, Geography
Petroleum and Natural Gas
Mining and Geophysics
Mineral Economics
Fuel Technology
Metallurgy
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Correspondence Instruction
Mineral Industries Research

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EXPERIMENT STATION

G. S. Scott, who was located at the School of Mineral Industries for the past three years as Assistant Director of Scientific Research for the Anthracite Institute, and who left State College on August 1 when the Institute ceased its research activities, has been back in town for the past two months conducting experiments at the local Sewage Plant on the use of anthracite in sewage treatment. This work was done for a New York corporation. Mr. Scott completed his experiments on December 18 and has again taken his departure. His permanent address is East Mauch Chunk, Pennsylvania.

Dr. S. T. Yuster, a graduate of the University of Minnesota, joined the Experiment Station staff on December 1, as Research Assistant in Petroleum and Natural Gas. Dr. Yuster takes the place of Dr. W. S. Walls, who resigned to take a position with the Sloan and Zook Companies.

At the recent election of officers of the Central Pennsylvania Section of the American Chemical Society, A. W. Gauger was elected Chairman and N. W. Taylor, member of the Executive Committee.

Recent Trends in Coal Research

(Continued from page one)

In the early part of the last year samples of these coals were examined by myself in cooperation with H. Lupke[8]; some of these observations may be reported here. The pore space of the coals was very low and comprised only about 2% of the volume of the specimens in their natural state. The specific gravity was about 1.4. It is obvious that in all of these cases one has to do with very dense material. This is consistent with the fact that the cell lumina are nearly completely filled.

The results of a qualitative and a quantitative analysis as well as of a separation analysis are reported in the following table. The results obtained were supplemented by means of an exhaustive methylation of the coals and an analysis of the methylated products. Finally a cautious oxidation for the purpose of transforming the humic part of the coal into acetone soluble dehydrohumic acid was carried out; also a strong oxidation to destroy all plant material except cellulose and other resistant plant residues. (Figure VI.)

FIGURE VI. DATA CONCERNING SOME COALS OF THE CHALK PERIOD

	Aix-la-Chapelle	Steyeregg	Lowenberg
Apparent specific gravity	1.32	1.41	1.37
Actual specific gravity	1.35	1.44	1.39
Space of pores	2.33%	2.07%	1.44%
Scratch	Brownish-black	------	------
Donath Test	Very weak	Weak	Very weak
Benzene extract	Faintly fluorescent	Not fluorescent	Very faintly fluorescent
Proximate Analysis			
Water	17.92%	9.2%	8.88%
Ash	0.56%	2.45%	4.96%
Coke	44.87%	48.07%	50.85%
Volatile	37.21%	42.69%	40.27%
Proximate and ultimate analysis on a dry ash-free basis			
Coke	44.87%	48.07%	50.85%
Volatile	37.21%	42.69%	40.27%
C	71.45%	67.00%	70.26%
H	5.24%	3.98%	4.46%
H disp.	2.72%	0.57%	1.54%
S	2.92%	1.26%	0.92%
N	0.43%	0.51%	0.67%
O	20.16%	27.25%	23.33%
Bitumen	5.0%	5.4%	4.4%
CH_3O	2.3%	4.4%	6.4%
COOH	ca 1%	1.3%	0.84%
OH	ca 8%	6.7%	0.95%

In one respect the Xylites of Aix-la-Chapelle have a unique feature not possessed by the other two coals; they are the only ones producing a well-baked coke. The examination of these different coals of the chalk period and especially of the samples of Aix-la-Chapelle renders an insight into the origin of bituminous coal, which is based exclusively on direct experimental evidence. In this case a specific biological process of filling the cells of vascular plants with considerable amounts of substance most probably of microbial origin caused production of a young bituminous coal.

With a knowledge of the coals of Aix-la-Chapelle, we certainly are not compelled to assume that heat and pressure are necessary factors in the formation of bituminous coals. But, of course, these factors most certainly did play an important part in causing characteristic features of different types of bituminous coal. Especially the transformation of bituminous coal into coals like anthracite can scarcely be conceived, without the assumption of heat and pressure. Advantage was taken of the opportunity brought about by the invitation of Dr. Jongmans of the Geological Bureau of the mine district of Heerlen, to cooperate in his investigation of the bituminous coals of the basin of Limburg. Advancing from east to west and from lower layers to deeper ones, one finds in the district of Limburg, nearly every type of coal from bituminous coking coals to anthracites. Geological circumstances are nearly the same with all of these coals. A petrographical and microscopical investigation carried out by Dr. Koopmans of the Geological Bureau of Heerlen revealed that all these coals gave, on a special treatment, about the same microscopical image. Therefore, one can be certain that in this case, the differences between the various samples of coal are caused mainly by the influence of pressure and heat.

Some methods used for describing these gradual alterations were developed in cooperation with one of my assistants, Dr. Clermont[9]. For this investigation, about 50 samples of coals collected with all precautions and illustrating every possible position both from east to west and from top to bottom in the Limburg mines, were used. The influence of heat is marked by a decrease of material soluble in pyridine and furthermore a decrease of certain hydrogen atoms which could be removed at a temperature of about 200°C. (392°F.) in the form of sulphur hydrogen.

These results can be outlined briefly as follows: the action of heat makes the coals more and more aromatic in nature; as to the influence of pressure, only an assumption can be made, namely, that high pressure causes an increase in average molecular weight by forcing various compounds to combine and form more complicated compounds, similar perhaps as a first step to the "simplexes," the latest conception of Willstatter.

One can thus attack and explain the origin of coal like the Xylties, brown coals and young bituminous, without applying more than a selection of analytical methods to the fuels found in nature. These methods, however, are not sufficient to give an insight into the mechanism of the formation of such coals, as between bituminous coals and anthracites. Questions of the nature just touched here, namely "aromatic nature," or "removable hydrogen atoms," require the application of all the methods used in the study of the constitution of other natural products. The same questions of constitution are, of course, important even at the very beginning of the whole sequence of transformation; namely the constitution of plant constituents, such as cellulose, lignin, and proteins.

(Concluded in February Issue)

In the absence of George J. Bair, who is taking his doctorate at the Massachusetts Institute of Technology, his work is being carried on by Dr. Francis J. Williams. Dr. Williams is a graduate of Alfred and of the Ohio State University.

DEPARTMENT OF CERAMICS

On November 20, Dr. Nelson W. Taylor addressed the students and faculty of the New York State College of Ceramics. His subject was "The Nature of Glass," in which he dealt primarily with the problem of viscosity of silicate melts, and showed how a good qualitative picture could be obtained from our knowledge of the structure of glass and crystals as derived by X-ray examination.

Dr. Taylor also consulted with members of the staff of the research laboratory of the Corning Glass Company on this problem.

Dr. Francis J. Williams and Dr. Nelson W. Taylor presented a paper at the Christmas meeting of the Geological Society of America on "Reactions Between Solids in the Absence of a Liquid Phase in the System CaO-MgO-SiO_2 in the Temperature Range 600° and 1200°C". In this paper it was explained that these solids were thoroughly mixed, pressed into discs, subjected to different heat treatments, and then X-rayed in order to see what changes were taking place. The work was carried on in the ceramics research laboratory and was supported by the Geological Society of America.

Dr. Taylor is in charge of a symposium on "Factors Affecting Rates of Change in Refractory Systems," which will be presented at the national meeting of the American Ceramic Society in Buffalo next February. At this meeting papers will be presented by the following: C. W. Parmelee and J. H. Chesters of the University of Illinois; C. C. Furnas of Yale University; L. Navias, General Electric Company; T. H. Riddle, Champion Spark Plug Company and A. B. Peck, University of Michigan; George W. Morey of the Geophysical Laboratory ;Gordon R. Pole and Nelson W. Taylor, The Pennsylvania State College.

FUEL TECHNOLOGY

Dr. James A. Taylor recently joined the staff as Research Assistant in Fuel Technology. Dr. Taylor's undergraduate training was obtained from the University of Iowa where he received the degree of BS in Chemical Engineering in 1928. He later studied at the University of Washington, holding a Bureau of Mines Fellowship for two years. He received his Ph.D. degree in 1932 from the University of Washington. His research was on "Problems in Froth Flotation of Coal".

After receiving his Ph.D. degree, Dr. Taylor spent approximately two and a half years as Assistant Chemical Engineer in the Northwestern Experiment Station of the U. S. Bureau of Mines at Seattle, Washington. He will devote his attention at Penn State to the problem of clinkering of bituminous coal ash sponsored by the Central Pennsylvania Coal Producers' Association.

DEPARTMENT OF MINING

Wm. R. Chedsey, Professor of Mining, attended a meeting of the National Mine Rescue Association in Pittsburgh on Tuesday, December 4. He is a member of the Publicity Committee of the Association which made a report at the meeting.

The next two days, December 5 and 6, he attended the meetings of the Coal Mining Institute of America, also in Pittsburgh. He was elected Second Vice President of the Institute and in the session devoted to the services of the United States Bureau of Mines to the mining industry he gave a paper evaluating the services of the Bureau to mining education.

Excerpts from Professor Chedsey's paper indicated the importance and value of the work of the U. S. Bureau of Mines in all departments of College educational work. In resident instruction, he pointed to the data on Safety Organizations for Mines and the services of the Bureau in correlating and practically standardizing such work which is of vital importance in resident instruction work in mining.

The work of the Bureau's Safety Division has made it easier for College Extension organizations to carry on a program, as the habit of class work has already been formed by the work which was offered by the Bureau. In research work the Bureau has always taken the lead and continued to do so insofar as its funds would permit. Their hearty cooperation with College research projects is notable and highly commendable. In addition, their research projects have been of such vast scope that the average individual engineer could not have undertaken them alone. Their research projects employ college trained men and the additional training acquired in the Bureau offers those men additional training which is invaluable both to the Bureau and in case they should desire to seek employment elsewhere.

While in Pittsburgh, Professor Chedsey completed arrangements for having presented to the Mining Department of the College a sectional Cardox shell, a device used in breaking down coal and acting much like an explosive.

EXTENSION DIVISION

The Division of Mineral Industries Extension is the youngest of the existing agencies of the College extension service. In a little over three years it has organized a fundamental educational program for the workers employed in the basic mineral industries of the State, including Mining, Petroleum and Natural Gas, Metallurgy, and Ceramics.

The educational efforts for the workers in the several fields include a three-year program of study. The work is standardized and is, therefore, uniform all over the State for any given course of study. Diversification from the basic text is permitted, in order to meet with local problems encountered in certain communities.

Three textbooks are prepared for each subject; one for each year of the course. These textbooks are written by the personnel of the Mineral Industries Extension Division with the assistance of the resident teaching staff of the School, every member of which is considered as an integral part of the extension division. Such rapid strides are being made in processing, through the aid of applied research, that it is an impossibility to maintain the extension text material up to date. Revisions of the texts are being made and will continue to be made, to include the latest findings of research, just as rapidly and as often as the personnel and limited funds of the division will permit.

The current year is by far the most successful in the brief history of the extension division. To date, there are 2,644 men enrolled, more than one-half of the number of students enrolled in resident instruction on the campus. Mining, being the oldest curriculum leads, with 1,477 students enrolled—640 in Anthracite mining and 837 in Bituminous mining. Petroleum and Natural Gas, now in its third year as an organized curriculum is second, with 1,003 men enrolled. Metallurgy is next with 151 men and Ceramics, the baby of the group, is last with only eleven men enrolled. The following table summarizes the work of this department to date:

Division of Mineral Industries Extension Activities for 1934-35

Curriculum	Number of Centers	Number of Classes	Total number of Men Enrolled
Ceramics	1	1	11
Metallurgy	4	5	151
Mining			
Anthracite	10	27	640
Bituminous	28	38	837
Petroleum and Natural Gas	28	35	1005
TOTALS	71	106	2644

Another important function of this Extension Division is the Correspondence Instruction department. Courses are offered in Ceramics, Geography, Geology, Metallurgy and Mineralogy. There has been a substantial increase in the number of persons served this year. Many additional requests for correspondence courses—in Ceramics, Mining Engineering and Petroleum and Natural Gas Engineering—could not be met because we were not prepared to offer these subjects by correspondence. Plans are being perfected which will permit an increase in the personnel of the Division sufficient to meet all future requests for such instruction.

TECHNICAL MEETINGS

Members of the Staff of the School of Mineral Industries took part in technical society meetings during the holiday season.

Papers were presented by the following:

DR. F. M. SWARTZ—"Silurian Sections near Lock Haven, North Central Pennsylvania." Geological Society of America, Rochester, N. Y.

DR. HELMUT LANDSBERG—"Observations of Condensation-Nuclei in the Atmosphere." Meteorological Society of America, (joint meeting with American Association for the Advancement of Science) Pittsburgh, Pa.

Others who took part in meetings were: Dr. A. P. Honess, Professor C. W. Robinson, Dr. A. W. Waldo, Geological Society of America, Rochester, N. Y.; Dr. Raymond E. Murphy, American Geographical Society, Philadelphia; and Dr. Gerald L. Hassler and Dr. Charles R. Austin, American Association for the Advancement of Science, Pittsburgh.

Dr. D. F. McFarland attended the meeting of the Committee on Programs and Publications, American Society for Metals, Cleveland, Ohio.

Dr. Frank M. Swartz and his father, Dr. C. K. Swartz of Johns Hopkins University, will present a summary of their studies of the Silurian rocks of West Virginia and Virginia, to a committee of the National Research Council on the Stratigraphy of North America. This material will be used in the preparation of a handbook of the Silurian Rocks of North America, which the National Research Council expects to publish.

COLLEGE SEISMOGRAPH STATION

The December issue of MINERAL INDUSTRIES carried the announcement that the School had installed a station to record earthquakes. This installation places the College among the 29 colleges or universities in the United States which are equipped with seismographs for such studies. The seismograph of the College was built in the Mineral Industries shop and is set up in the lowest available point within the Building, namely, in an unused elevator shaft six feet below the basement level. But even there, special arrangements had to be made to insure a solid foundation which would eliminate the vibrations caused by machinery in and traffic around the building. A hole was dug to bedrock and a concrete pier was anchored to the rock in the bottom of this hole. This gave a foundation which had no connection whatsoever with the foundation of the Building and avoided most of the disturbing influences. The seismograph was set up on this foundation and here it carries on its records automatically and photographically. The recording set was loaned to the College by United States Coast and Geodetic Survey.

The story leading to the development of modern seismograph instruments is very interesting: "More than 3,000 years ago the Chinese recorded earth movements by completely filling a tube with mercury and when a drop of mercury fell out of the tube, they recorded an earthquake."

"Galileo, in the middle of the 17th century, laid the foundation for the modern instruments. The story is told that he was once attending church and noticed how one of the large chandeliers began to swing. From this he developed the principle of the pendulum as a recording instrument for earth movements. A sheet of paper was placed on a solid foundation beneath a pendulum so that any motion of the earth caused the pendulum to swing and to scratch lines upon the paper."

Today by means of a reflected light beam from a mirror which is fixed to the steady mass of the seismographic pendulum, the relative movement of the pendulum against its surroundings are recorded. By this means it is possible to obtain magnifications of 5,000 times the extent of the ground movements. Under the present conditions of the mineral industries seismograph installation, however, our set-up is limited to magnifications of about 300 times.

"As the X-ray shows us what is contained beneath the surface of man, so the earthquake waves reveal to us what is contained beneath the surface of the earth. These waves are the only exact means of revealing such facts.

"When an earthquake occurs, the nearest station records it first and distant stations relatively later. The travel time of the waves depends upon the kind of rock that these waves must pass through, and by comparing the times that the different stations record the earthquake, it is possible to tell what kind of rock exists under the surface of the area affected. A clock attached to these machines is always kept within two-tenths of a second of the correct time.

"By this means it has been pretty well established that it is about 1,800 miles to the core of the earth, which is supposed to consist of heavy metals such as iron and nickel."

The upper part of the earth's crust is of modern interest because of the commercial value of its deposits. Valuable deposits are easier found if accurate information on the structure of this crust is available. A good and complete net work of seismographic instruments facilitates such information.

There are approximately 400 seismographic stations in the world, most of these being located in Japan and in Europe. An area the size of Pennsylvania should have at least 12 stations, but there are at present only 2 other stations in Pennsylvania, those being located at the University of Pittsburgh and at the Franklin Institute in Philadelphia and these have both been installed within the last few years. There are only about three dozen seismograph stations in the entire United States and a large percentage of these stations are located in California.

The United States Coast and Geodetic Survey has one system of seismograph stations and the Jesuits have another system; the Jesuit net work has been established much longer. The station of The Pennsylvania State College is affiliated with the United States Coast and Geodetic Survey system.

The Pennsylvania State College seismographic station is only in its infancy and is still in the experimental stage. It consists only of a minimum of equipment but Dr. Helmut Landsberg, in charge of the station, hopes to get a chance to build it into a well equipped station within the next few years.

MUSEUM NOTES

Professor C. W. Robinson has been appointed Curator of the Mineral Industries Museum. He has undertaken the work of arranging the exhibits so that the attractiveness and educational value of these may appear to the best advantage, and has recently visited several museums in Pennsylvania and New York City to study museum methods. The different articles are being numbered and catalogued so that a permanent record will be available. Cards are being made giving the history of each piece and notes of scientific or other educational interest; in case of gifts the name of the donor will be included.

Six new display cases have been installed in the corridors of the building. Other new cases will be added and old ones reconditioned as rapidly as funds become available for the purpose.

The Curator will be glad to make appointments with visitors who wish to see the museum if they will call the Department of Geology.

Friends of the College who may have articles of interest to the public along our line could increase the educational value of such objects and give them greater publicity by exhibiting them in our museum. A note sent to Dean Steidle's office, to the Curator or the heads of the various departments in this School would receive prompt attention. Articles relating to Geology, Geography, Mineralogy, Petroleum and Natural Gas Production, Petroleum Refining, Mining, Metallurgy or Ceramics would be of interest in this museum.

A recent addition of unusual interest was made to our mine safety lamp collection by Mr. H. I. Smith '07. This was a vest pocket Davy safety lamp dating back to about 1800, and still in perfect condition. A description of this lamp and other exhibits will be given in later issues of MINERAL INDUSTRIES. Mr. Smith has been exceedingly generous in personal gifts to the museum and has been active in securing very valuable donations through others.

The Curator is experiencing some difficulty in tracing the history of several of the exhibits. If any of our readers have knowledge concerning these and especially of personal gifts, it would be greatly appreciated if they would write the Curator giving full details.

RESEARCH SEMINAR

The Research Seminar for 1934-35 was organized for its first meeting on November 8. Professor O. A. Knight gave a very interesting discussion of his research work on the Austenite-Martensite tranformation in alloy steels at liquid air temperatures. This talk was illustrated by motion pictures which showed the transformation in process. Following the motion pictures considerable discussion of the problem took place from the floor.

The second meeting of the Research Seminar was held on November 22 with Dr. H. W. Nelson as speaker. Dr. Nelson's topic was the oxidation of pyritic sulfur in bituminous coals. This problem, which was originally suggested by the late Professor Parr of the University of Illinois, was the subject of Dr. Nelson's research work for approximately two and a half years.

"THE UNSEEN EMPIRE"

Any person wishing to be furnished with concrete evidence as to why Congressional effort should be directed to restoring the appropriation to the Federal Bureau of Mines, should read the booklet entitled "The Unseen Empire," published by the American Mining Congress, Washington, D. C., 1934.

This booklet covers in detail the value of the mineral industries to the United States through the part played by the Federal Bureau of Mines in making the mineral industries a safer place in which to work and in assisting those industries in obtaining greater economies of production. It is common knowledge that the Federal appropriations to the Bureau have decreased in the last few years to such an extent that the Bureau is hampered in performing those functions definitely assigned it by law to the detriment of the mineral industries in particular and the well-being of the United States in general.

This booklet may be obtained gratis by addressing the above mentioned source.

Some statements of facts excerpted from this book follow: "Mineral substances are produced in approximately two counties out of every three, Federal records reveal. In the remaining counties, manufacturing operations depend widely upon minerals."

"In five years (1924-1928), mineral producers paid almost six times as much as farmers in Federal taxes."

"Bureau of Mines funds were about one-fifth of agriculture appropriations during the 1924-1928 period."

"The number of miles of track laid underground in Pennsylvania is greater than the mileage of railroad tracks spread over the surface of this State."

"Like all governmental agencies, the Bureau of Mines is dependent upon Congressional appropriations, and the volume of these appropriations dictates absolutely the extent of its ability to perform duties assigned to it by law."