

WM. PENN'S MINERAL HERITAGE

Mineral Industries, from Minor Role in Early Days,
Evolve into Pennsylvania's Chief Source of Wealth

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AGRICULTURE AND MINERALS

constitute the primary source of all wealth. With a diversity of soils and a remarkable mineral endowment it is natural that Pennsylvania should be among the leaders as a contributor to the prosperity of the nation.

The fundamental contribution of agriculture is unquestioned. Until man had food and clothing in a dependable supply he was able to make but little progress in a material way. Development of an industrial civilization has been accompanied by a constantly increasing consumption of minerals. This has been particularly noticeable since 1900. Since that date mineral production has progressed by leaps and bounds so that problems of conservation and depletion are steadily increasing.

Extraction and primary processing of minerals supply the principal source of employment, as well as revenue, in Pennsylvania. The key men in these industries are mineral engineers and mineral technologists; the mass of labor are miners and productive workers engaged in primary processing. The School of Mineral Industries combines every branch of mineral industries instruction, extension, and research, in acknowledgment of Pennsylvania's superiority as a mineral industrial State.

In the following discussion, the year 1937 has been selected as a representative year. It was a year of reasonable activity and recovery from the depression and one but little touched by the stimulation of war.

Mineral Production

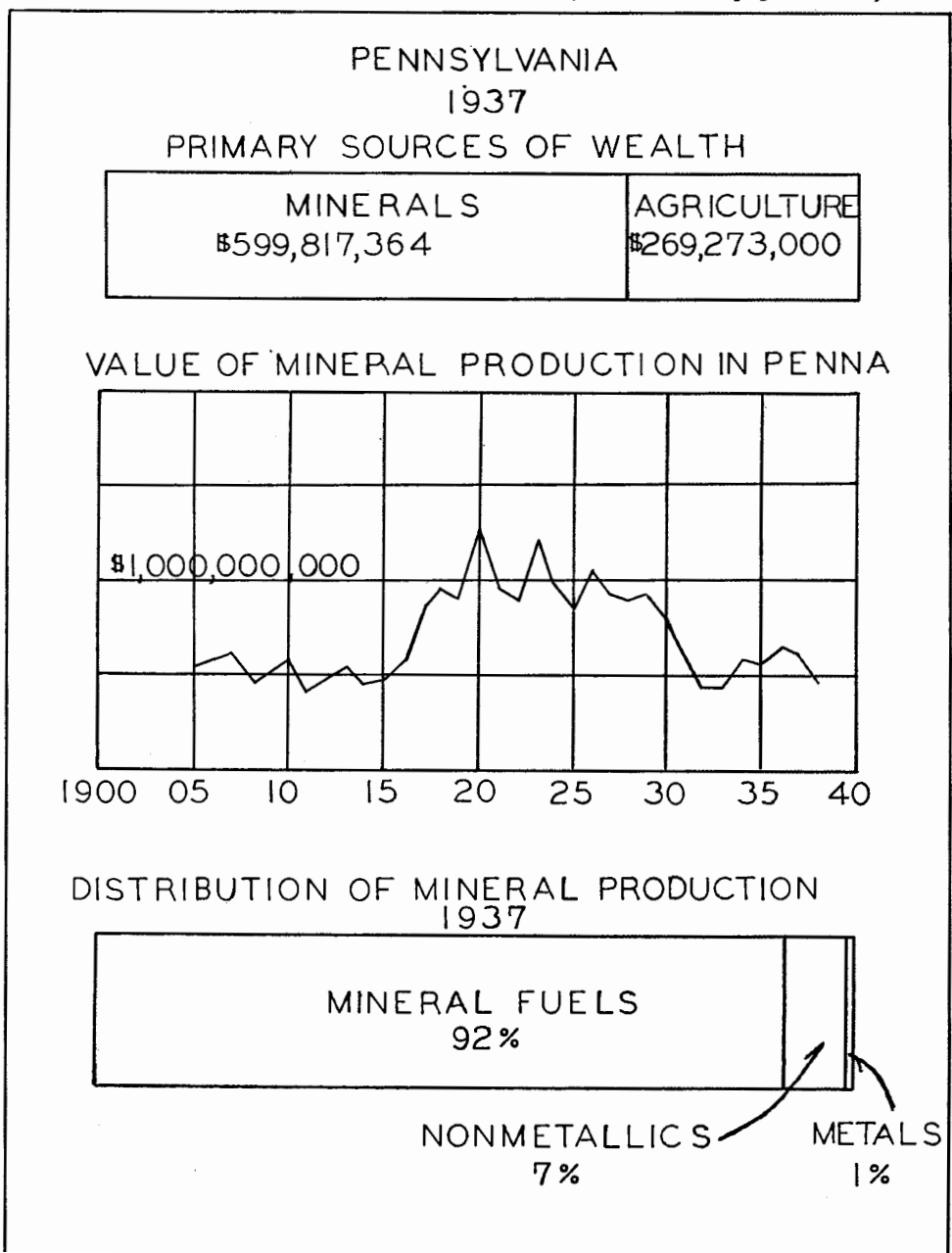
Fig. 1 illustrates the basic elements of industry in Pennsylvania. It is of interest to note that for a number of years the annual value of mineral production actually exceeded one billion dollars, a figure not yet attained by any other state. The distribution

as a producer of coal. Anthracite, bituminous coal, petroleum and natural gas, the mineral fuels, composed 92 per cent of the State's mineral production. The nonmetallics which supply the raw materials for the cement, lime, ceramic, glass and other industries fall in second place.

Production of metallic ores is restricted largely to iron, and while the value is only one per cent of the whole it renders a great service to the steel industry in the eastern part of the State.

Fig. 2 represents a more detailed study of the dollar valuation of mineral production. Again the mineral fuels exhibit their dominant position. Their dollar value in this year was a

(Continued on page 2 col. 2)



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

Fields of Work

Earth Sciences: Geology, Mineralogy, Geography, Geophysics, Meteorology, and related subjects. **Mineral Economics:** Economics and conservation of minerals. **Mineral Engineering:** Mining Engineering, Mineral Preparation, and Petroleum and Natural Gas Engineering. **Mineral Technology:** Fuel Technology, Metallurgy, and Ceramics.

Divisions of Service

Resident Instruction
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MARCH 1941

TRENDS and OBJECTIVES

BY DEAN EDWARD STEIDLE

WHAT ARE THE FACTS?

PENNSYLVANIA is in the front rank in the extraction of minerals and processing of mineral products—activities indispensable in the maintenance of the comforts of modern

living, national defense and our democratic institutions. The School of Mineral Industries trains men to serve society better by preparing them to participate in and advance the interests of these industries. The resident instruction, extension instruction, and research of the School combine to insure the future prosperity of the Commonwealth.

A portion of the time of an executive officer in technical education must be spent in attempting to fathom the economic and social implications of all technical advancements. An imposing list of questions sufficient to qualify for an "information please" program requires special attention from time to time.

What are the trends of certain mineral industries in Pennsylvania which must be taken into consideration in order that graduates will be prepared to meet the demands of the

Mineral Industries Evolve from Minor Role Into Pennsylvania's Chief Source of Wealth

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little more than three times the value of all the gold produced in the United States. Their actual value as measured in terms of service to man and industry is incomparably greater. The romance of gold mining is more apt to attract the interest of the public than are the more commonplace activities associated with the production of coal and petroleum in Pennsylvania. Stone, in the production of which Pennsylvania leads the country, heads the list of nonmetallic minerals. It supplies the material for construction, railroad ballast, flux for the blast furnaces, and the necessary raw material for the manufacture of lime, cement, and other industrial com-

modities. Although small amounts of copper, silver, and gold are produced in Pennsylvania, the total is insignificant and iron supplies the principal contribution to the metallic group.

Primary Processing

Fig. 3 shows the position of the primary mineral processing industries as employers and wage payers. The general pattern changes from that shown by the mineral raw materials. This is due to the fact that mineral processing within the State utilizes large amounts of other materials shipped in from outside points. These imported minerals serve in a co-operative manner with local supplies. Steel and rolling mill opera-

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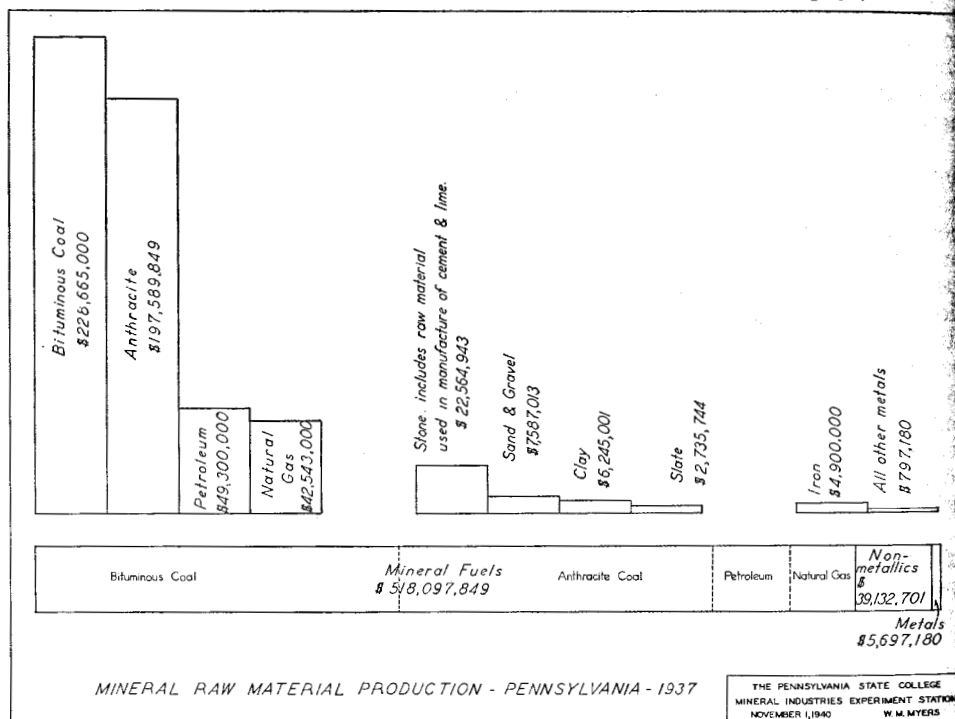


Fig. 2

future? What minerals are there in the State, in what quantity did these minerals exist originally, how much has been used, how much wasted, what can be done with what is left, how many people depend upon these resources for a living, what income does the State derive from mineral exploitation, how may improved technology guarantee supplies for the future, how may minerals of limited utility be made serviceable to man?

These are the questions which with some variations are continually present. To obtain accurate data upon which future decisions may be based it becomes necessary to pay more and more attention to factual material. This involves studies in the economics of the mineral industries and in these studies the effects of improved or new

technologies must be allowed for. Dr. Myers is presenting the results of some of these studies on the accompanying pages.

The leadership of Pennsylvania in the mineral industries is readily apparent. The losses sustained by certain industries also are painfully evident. The hazards which threaten others can not be seen so clearly. Such graphic representations assist in the realization of the overwhelming importance of the mineral industries in the life of the Commonwealth and the trends for better or for worse which are exhibited. At the present time, when national defense is of paramount importance, the significance of these industries in the support of democracy can scarcely be exaggerated.

tions employ the largest number of workers and maintain the largest payrolls. The shipment of iron ore to be reduced with Pennsylvania fuel is one of the largest raw material movements in the world. The glass industry leads in the nonmetallic group and is second only to steel as an employer. The availability of satisfactory fuels, particularly natural gas, has been of immense service to the glass industry. The presence of almost sands of superior quality in almost unlimited tonnage within the State has also been of fundamental importance in the development of this industry. In the refining of petroleum the crude oil of Pennsylvania supplies only a minor fraction of the total consumed. The rest is obtained from the Gulf states and South America. Measured from the viewpoint of valuation of production, the total refining industry is second only to the steel industry.

It is of interest to note that Pennsylvania occupies first rank in the United States in the production of coke, cement, glass, stone, blast furnace products, and steel. These commodities comprise the very fundamentals for normal economic existence and naturally assume far greater importance in times of war.

The value of products and the percentage which they contribute to the whole is supplied by Table 1.

Table 1.—Value of Products in 1937
Mineral Processing Industries
of Pennsylvania

| | Value | Per Cent of Total |
|---------------------------------------|-----------------|----------------------|
| Coke | \$ 92,576,111 | 4.7 |
| Manufactured Gas | 33,000,000 | 1.7 |
| Petroleum Refining | 259,696,775 | 13.2 |
| Cement | 34,722,934 | 1.8 |
| Clay products | 28,292,925 | 1.4 |
| Pottery | 8,935,249 | 0.4 |
| Nonclay refractories | 15,403,388 | 0.8 |
| Glass | 79,579,017 | 4.0 |
| Lime | 6,551,714 | 0.3 |
| Stone, cut and shaped | 6,037,473 | 0.3 |
| Blast furnace products | 229,075,759 | 11.6 |
| Foundry products | 31,847,644 | 1.6 |
| Nonferrous metals, except aluminum | 36,488,948 | 1.9 |
| Steel and rolling mill products | 1,109,843,163 | 56.3 |
| | \$1,972,051,100 | 100.0 |

Coke and Manufactured Gas

The coke industry for many years has been closely associated with the production of iron which has supplied the principal market. The suitability of beehive coke for blast-furnace fuel led to a steady expansion in its production. For many years this was the only type of coke produced and by-product coke did not appear in Pennsylvania until 1895. Since this year there has been a steady increase in the productive capacity of byproduct ovens. Byproduct coke first attained a greater tonnage than beehive coke

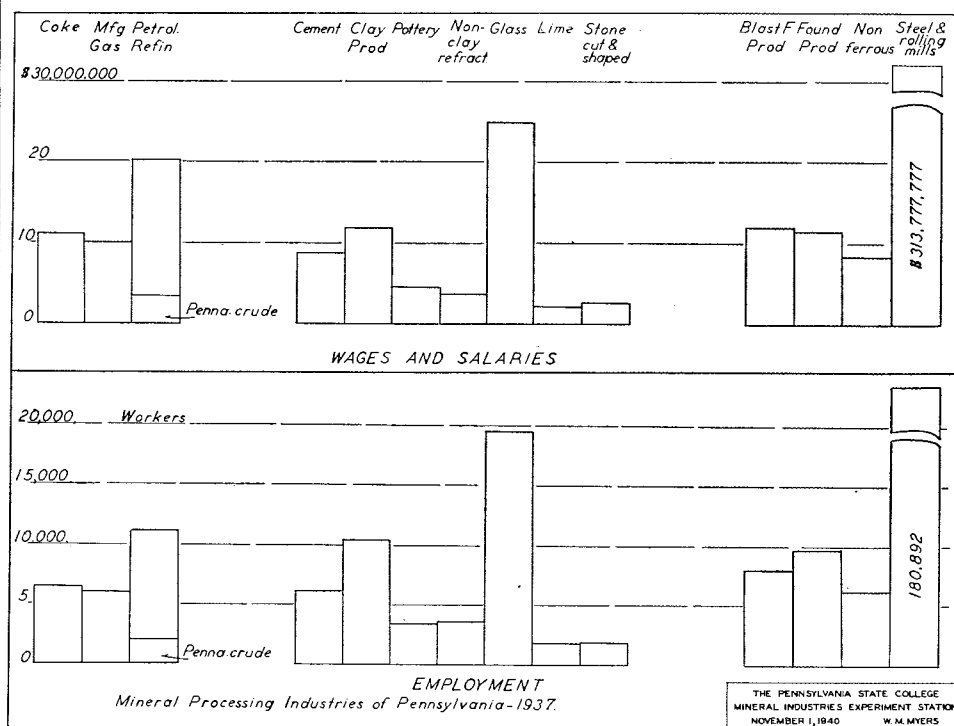


Fig. 3

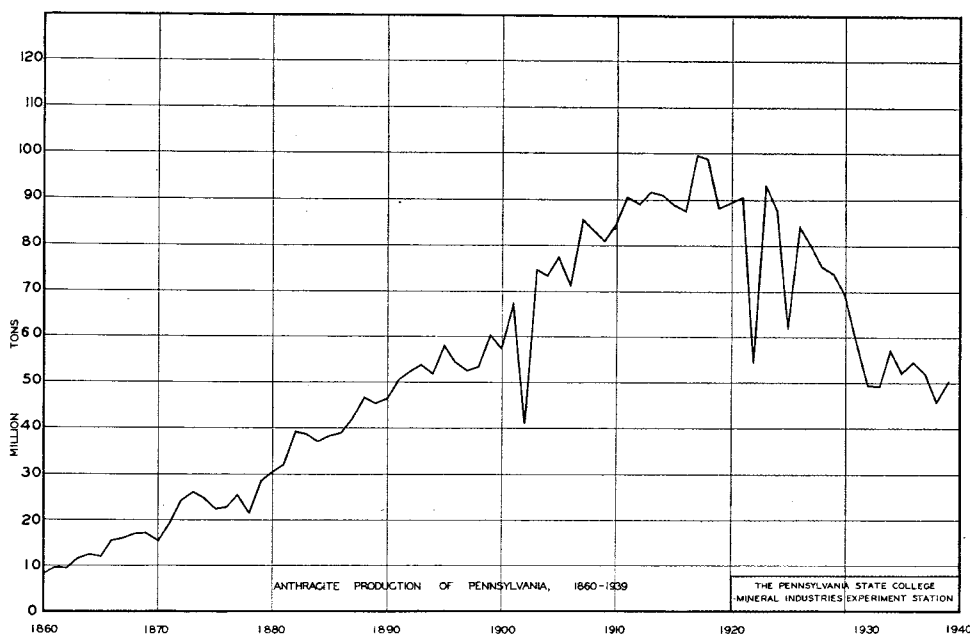


Fig. 4

tar and its associated products as a base for many dyes, drugs, explosives, and similar products and American interest in these materials was stimulated greatly. A somewhat similar condition is developing today under the impetus of national defense, and a substantial increase in coke producing capacity will be the result. Beehive coke production is becoming important again under the stimulation of mounting orders from the steel mills.

The production of manufactured gas is a substantial employer of labor and a large consumer of coal. Some anthracite is used in the production of water gas. The production of

Refractories

Pennsylvania leads the United States in the production of fireclay and the production and processing of this mineral is an active industry in Clearfield county. The industry is closely identified with the iron and steel industry and follows its fortunes closely. Refractory brick capable of resisting high temperatures are also used extensively in other industries where problems connected with high temperatures are present. Non-clay refractories also comprise an important industry. Ganister is used extensively in the manufacture of silica brick. Deposits of ganister rock are

for an indefinite period. Magnesite, chromite, bauxite, and some other minerals are imported by the refractory industries of Pennsylvania and converted into useful form for many special purposes.

Nonferrous Metals

The nonferrous metals include those other than iron and steel. Copper, its alloys brass and bronze, zinc, lead, and aluminum are among the leaders in this group. All play important roles in the industrial life of Pennsylvania. The actual production of the ores of these metals is insignificant in the Commonwealth. The processing and fabrication of the metals are valuable contributors to the employment of its citizens. Pennsylvania smelts more metallic zinc than any other state but of course is obliged to import zinc ores and con-

centrates from outside sources for reduction at the furnaces.

Building Stone

A great variety of building stone exists within the State. No outstanding type comparable to Indiana limestone or Vermont marble or granite is present. Consumption is therefore restricted to localized areas close to the point of production. Many building stones possessing attractive color and pattern are known to exist but are not quarried commercially due to lack of demand. While many of these materials seem promising enough to warrant use it is difficult to justify the investment which would be necessary to place them on the market.

Iron and Steel

The position of iron and steel in the economy of Pennsylvania is so out-

standing as to require little comment. Measured by the yardstick of employment, wages paid, investment, value of products or any other feature, its leadership is unquestioned. The fundamental sinew of modern war is now operating at almost 100 per cent of its rated capacity. A corresponding increase in business activity of all types in the steel-producing communities has been a welcome event.

Anthracite

The recorded production data for anthracite for the years 1880-1939 are represented in Fig. 4. Except for the dislocations caused by strikes in 1902, 1922, and 1925, the graph conforms to a general pattern. A steady increase in production is shown until 1917, when a peak of 99,611,811 tons was reached, due principally to the abnormal demands occasioned by the war. From 1917 on, the trend has been downward to a low of approximately 46 million tons in 1938, about equal to the tonnage produced fifty years before in 1888. During the past several years there has been an unrecorded production of "bootleg" coal but it is estimated that the maximum output of this coal has not exceeded 4,000,000 tons annually. Nevertheless, it is a large amount and represents an appreciable value. Examination of Fig. 4 without further analysis of the problem leads to the conclusion that the decline of the anthracite industry really began some time in the decade following the World War and was greatly accelerated by the strikes of 1922 and 1925. Examination of the population statistics of the area considered to be the normal market for anthracite and comparison of the population growth with production indicates that anthracite has lost ground steadily since 1910. The fundamental problems of the industry are essentially those associated with shrinking markets and they have been present for a greater period of time than is commonly recognized.

The conditions affecting the reserves of anthracite for future use are shown in Fig. 5. The total production of record from the date of earliest mining to January 1, 1941, is reported by the U. S. Bureau of Mines to be some 4,384,000,000 net tons. The actual production undoubtedly is considerably in excess of this figure. Estimates of reserves indicate that at an annual consumption rate of 50 million tons the present resources will last for 352 years. However, this figure is purely theoretical and does not allow for the waste of material incurred in mining operations. In any event, the reserve is large and suffi-

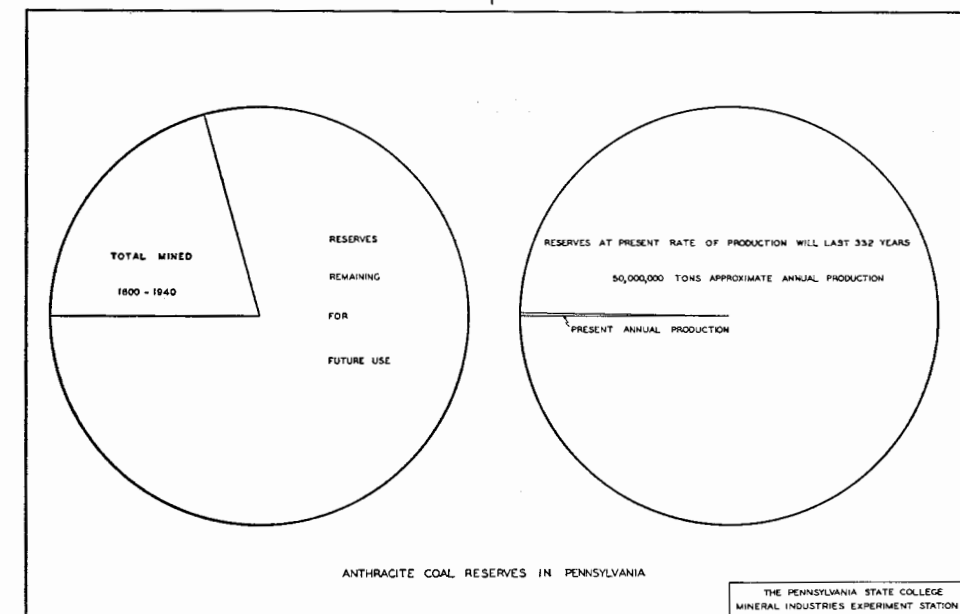
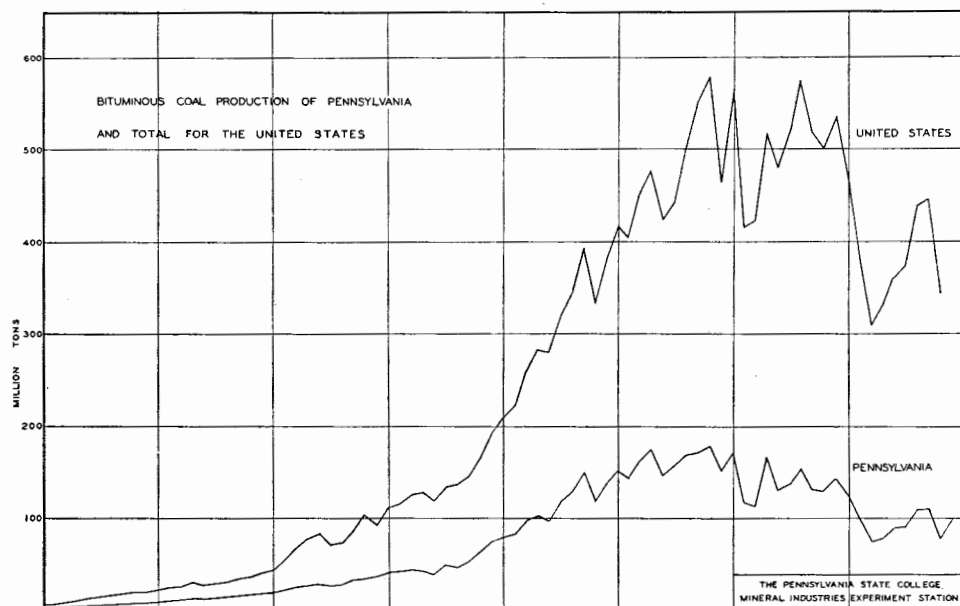


Fig. 5



thracite on a long range basis is, therefore, justified and desirable.

The anthracite industry is now operating at an annual tonnage little over one-half of its capacity. This loss in tonnage is the fundamental cause of what may well be considered to be Pennsylvania's most serious social and economic problem. Unemployment, declines in local business and real estate values, and rising relief costs all go hand in hand with shrinking volumes of production.

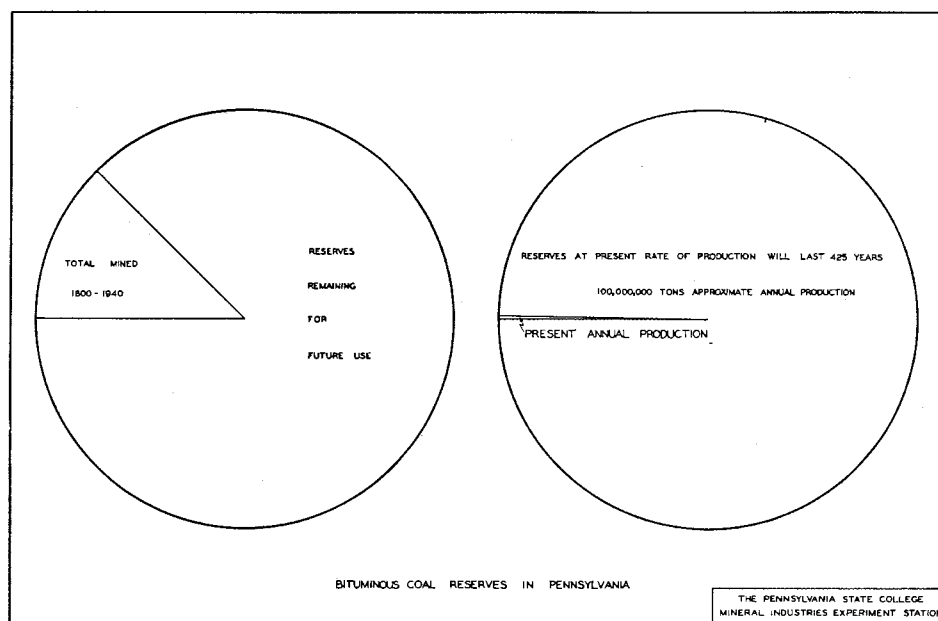
Anthracite finds its largest market in domestic heating, that is for household comfort. In this market it has encountered steadily mounting competition from other fuels. Fuel oil, derived from petroleum, has entered this market in constantly expanding amounts. The ease with which this fuel can be handled and its present price have aided its introduction.

The anthracite industry has been faced with steadily mounting costs. The general course of the industry has tended to follow that of many other mineral enterprises. That is, the most accessible and cheapest mined material has been exhausted first. Mining of necessity has been carried to greater depths and at constantly increasing operating costs. One of the most expensive problems associated with the mining of anthracite is the disposal of water. It has been pointed out recently that from 33 to 34 tons of water must be handled for each ton of coal recovered. This contributes very materially to operating costs.

Improvement of the competitive position of anthracite in the field of domestic heating can best be brought about by lowered costs to the consumer. Improvements in the technology of production and in the combustion of the fuel offer the most immediate prospects of success.

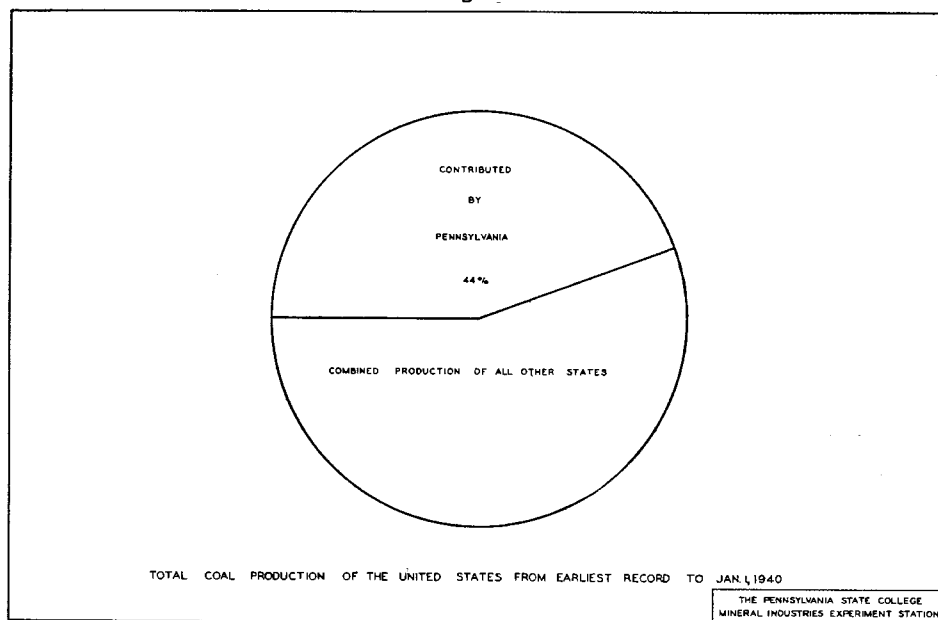
Bituminous Coal

Pennsylvania enjoys no such monopoly in the production and marketing of bituminous coal as it does in the case of anthracite. As bituminous coal is widely distributed in other states, the Pennsylvania industry is constantly facing competition from coal produced elsewhere. The industry is beset with many problems, some economic and some social. Increasing competition, advancing costs, local exhaustion of deposits—all contribute to the difficulties which the industry faces. Pennsylvania established leadership as a pioneer producer of bituminous coal at the beginning of the industry. This position was maintained until 1927 when it was lost for the first time to West Vir-



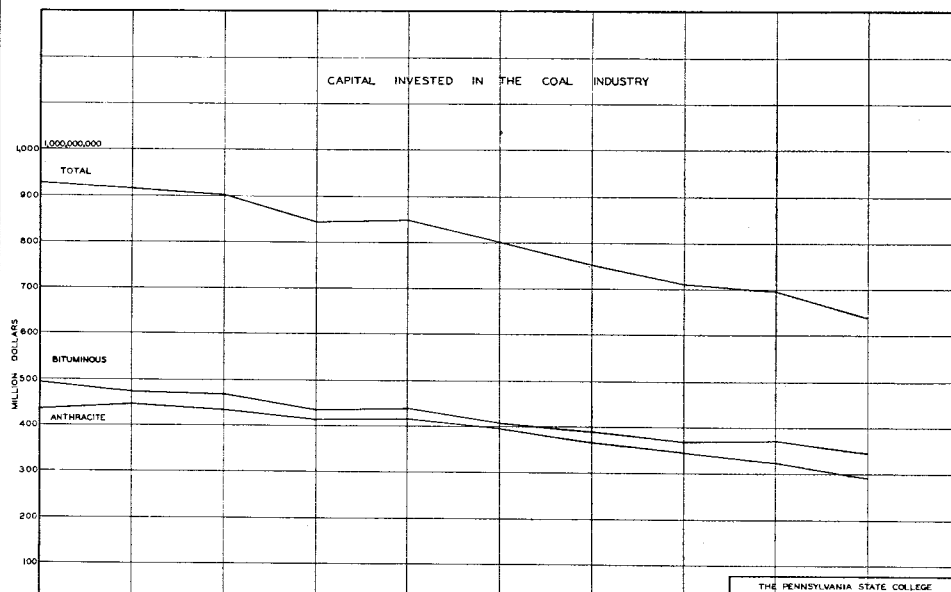
DATA: TOPOGRAPHIC AND GEOLOGIC SURVEY, HARRISBURG, PA.

Fig. 7



DATA: U.S. DEPT. OF INTERIOR, BUREAU OF MINES

Fig. 8



time has had to be content with being second to West Virginia.

Production for Pennsylvania and the total for the United States is given on Fig. 6. In 1850, production amounted to about one million tons. Since that date, expansion has been fairly regular and a peak amounting to 178,550,741 tons was recorded in 1918 under the impetus of the World War. This abnormal demand resulted in an increased capacity for production which became a serious problem in consequence of the diminished demands of later years. Bituminous coal responds to industrial stimulation far more readily than anthracite and in the past few months we have seen a marked increase in activity due to the soaring steel industry and other industrial demands associated with defense. Production in Pennsylvania in

1940 is reported by the U. S. Bureau of Mines to be 112,907,000 tons, a substantial increase over 1939, which reported 92,190,000 tons. This figure is far below the tonnages reported during the twenty-year period from 1910 to 1930 when annual production frequently ranged from 150 to 170 million tons.

The bituminous coal industry has encountered shrinking markets similar to the trend exhibited by anthracite. However, the decline has not been so spectacular or disastrous. During the past several decades, great advances have been made in the technique of fuel utilization. This has been most marked in such major consumers as central power stations, steam locomotives, blast furnaces, and cement mills. The increased efficiency in combustion is reflected in

a substantial decline in the amount of coal required, and the bituminous markets have suffered accordingly.

Bituminous coal displays far more flexibility than anthracite, particularly those types which coke readily and at the same time supply the by-products which have become the basis of such diversified industries. It also possesses definite possibilities related to the production of petroleum equivalents which may become of increasing importance in the future. Bituminous coal therefore has greater industrial stability than anthracite which is restricted at present to a more narrow field. It is hoped that research efforts now being applied to anthracite will result in broadening of the utility of this material so that it will be less dependent upon one market.

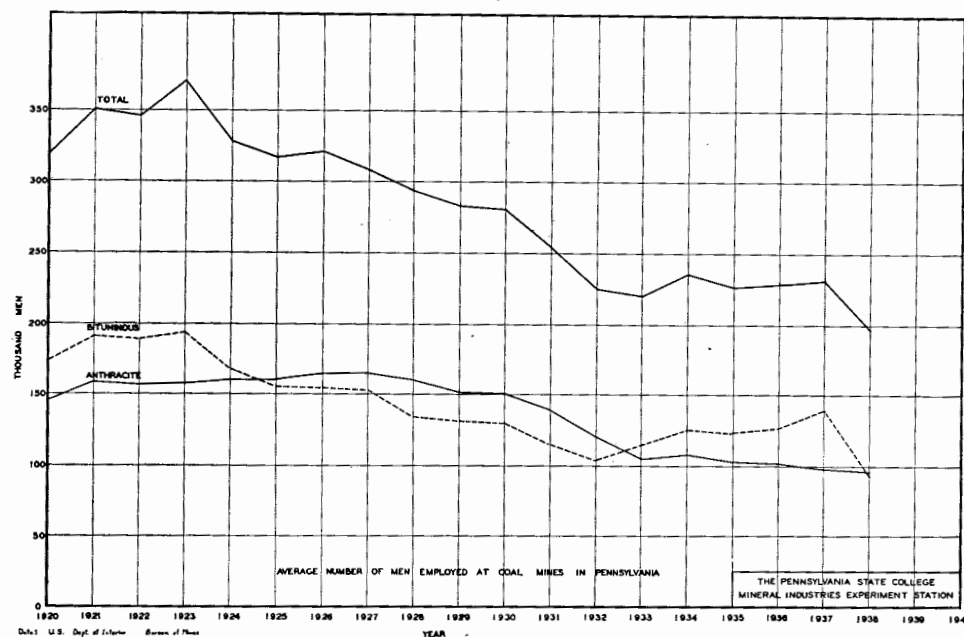


Fig. 10

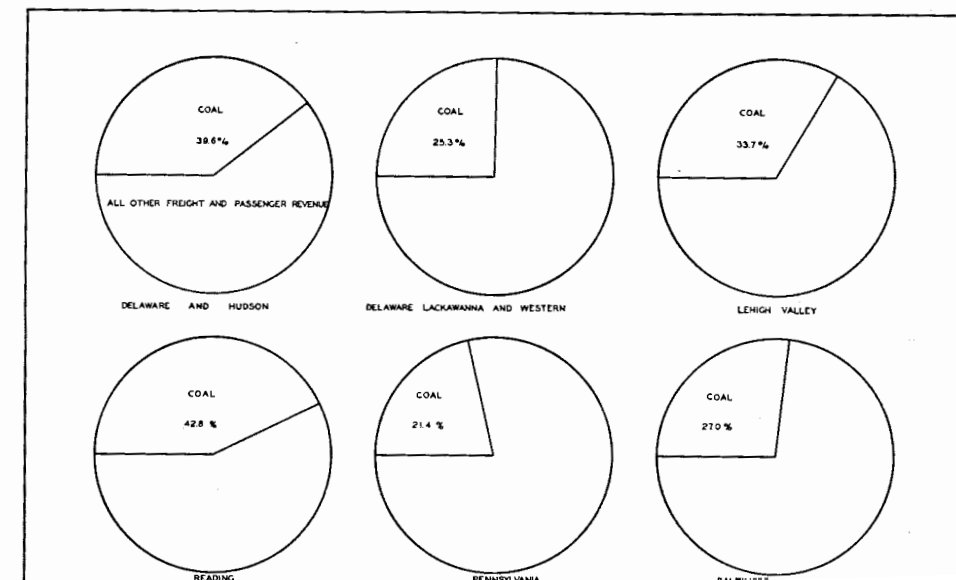


Fig. 7 illustrates the condition relative to the reserves of bituminous coal in Pennsylvania. Total production of record from date of earliest mining to January 1, 1941 is set at 6,170,988,000 net tons. Reserves are adequate at the present rate of consumption for generations. Again, we are dealing with a mineral resource of great future importance whose problems must be considered with that thought in view.

The total production of anthracite and bituminous coal is well over 1 billion tons, which is 44 per cent of all the coal produced in the United States since production has been made a matter of record. This is shown in Fig. 8.

The trend of capital investment in the coal industry is shown in Fig. 9. Both anthracite and bituminous coal display an almost steady decline. According to figures collected by the Department of Internal Affairs at Harrisburg, the capital investment in the anthracite industry declined from \$435,621,400 in 1929 to \$290,576,900 in 1938. During the same period the investment in the bituminous coal industry declined from \$493,366,300 to \$347,360,400.

The trend of employment like the trend of capitalization has been steadily downward. This trend for anthracite and bituminous coal is displayed in Fig. 10 which covers the years from 1920 to 1938. The decline has been most noticeable since 1929. Figures indicate that the number of wage earners in the anthracite industry dropped from 151,379 in 1929 to 86,100 in 1938. This decline has been one of the most drastic exhibited by any industry in the State. The disastrous

decline during the same period has not been so marked. The actual number of wage earners was 124,725 in 1929 and 104,838 in 1938.

Transportation of coal supplies many of the railroads serving Pennsylvania with their principal source of income. This is illustrated by Fig. 11. Other mineral products also contribute materially to railroad income. The railroads, therefore, have a vital interest in the future prosperity of the mineral industries.

Petroleum and Natural Gas

The production of petroleum in Pennsylvania has been continuous since 1859, when the first well was sunk specifically for that purpose. Production at first was small and it was not until after 1876 that output exceeded 10 million barrels annually. The period following the flush production of the 1890's was characterized by a steady decline. By 1910 this was so great as to indicate that the end of production was in sight as shown in Fig. 12. Since that year, the gradual development of new methods of recovery has rejuvenated the industry, and production has been brought back to levels approaching the best years of the past. This is one of the best examples which can be cited of the salvaging of a failing industry by the application of new technology.

When present methods of recovery are no longer effective there will still be a large proportion of the original petroleum left in the oil sands of Pennsylvania. The recovery of this material will be of increasing importance and will present a challenge to our best technical skills.

The production of natural gas was greatly increased by activity in the drilling of oil wells. For a long time the wastage of this superior fuel was permitted to occur with little or no effort to conserve it. It was not until the installation of pipe lines that gas could be saved and distributed in areas where it could be best used. The development of pipeline distribution now permits the transportation of gas from points outside of the state to the industries of Pennsylvania. The storage of gas underground in suitable geologic structures has provided a successful solution to an important problem.

Nonmetallic Minerals

The relative importance of the non-metallic minerals has been mentioned. Pennsylvania leads the country in the production of fireclay, slate, stone,

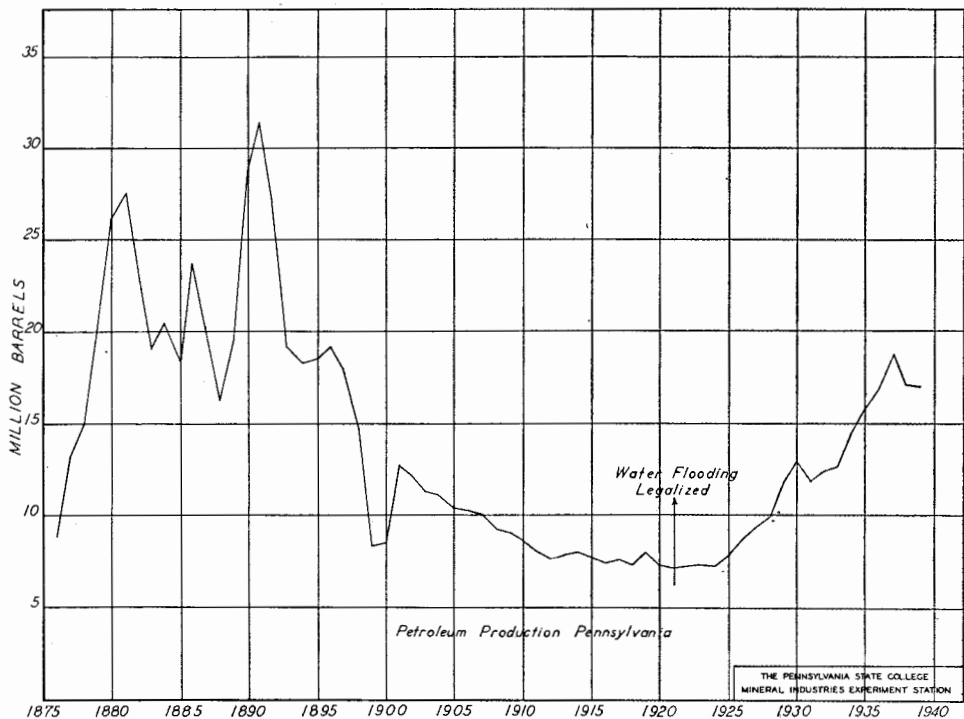


Fig. 12

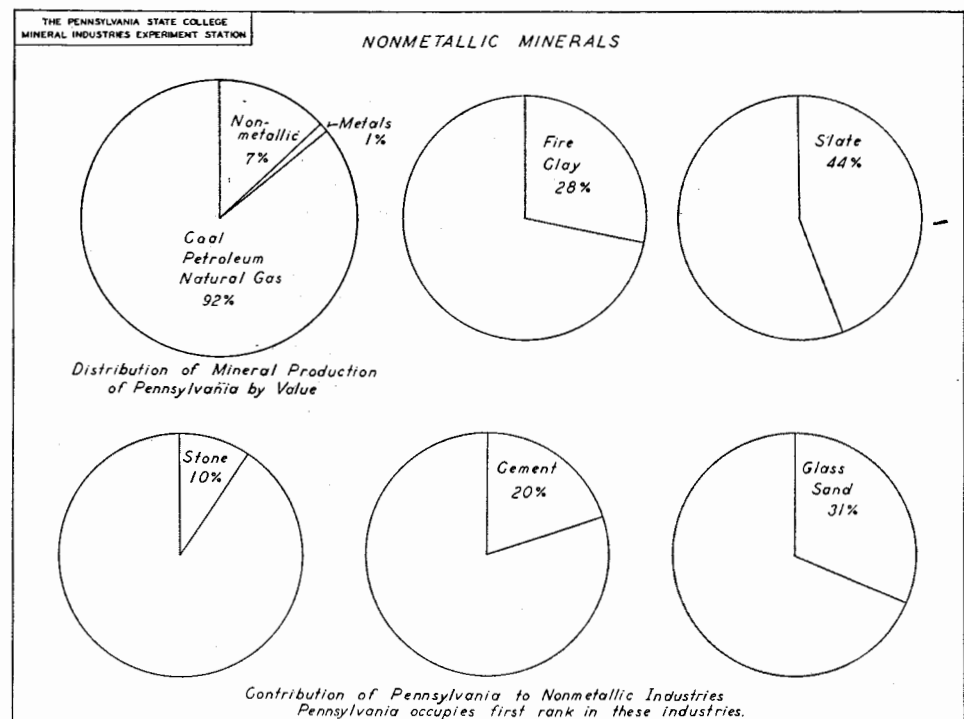


Fig. 13

ed by Pennsylvania is shown by Fig. 13. The unutilized portion of the non-metallic mineral endowment of the Commonwealth offers a challenge to technical skill. Very large tonnages of clay, limestone, dolomite, diabase, serpentine and other rocks and minerals exist. At present much of this material is useless due to the presence of undesirable impurities or to lack of knowledge as to how to employ its properties to the best advantage.

sylvania generally amounts to around 2 million tons per year. It now supplies only a small percentage of the total iron ores which feed our blast furnaces as is shown in Fig. 14. The possibility of expanding the iron ore production of the State has been investigated a number of times. While this would be a decided asset, the chances that any discovery will be made of great commercial significance seem most unlikely. The production of pig iron is a major indus-

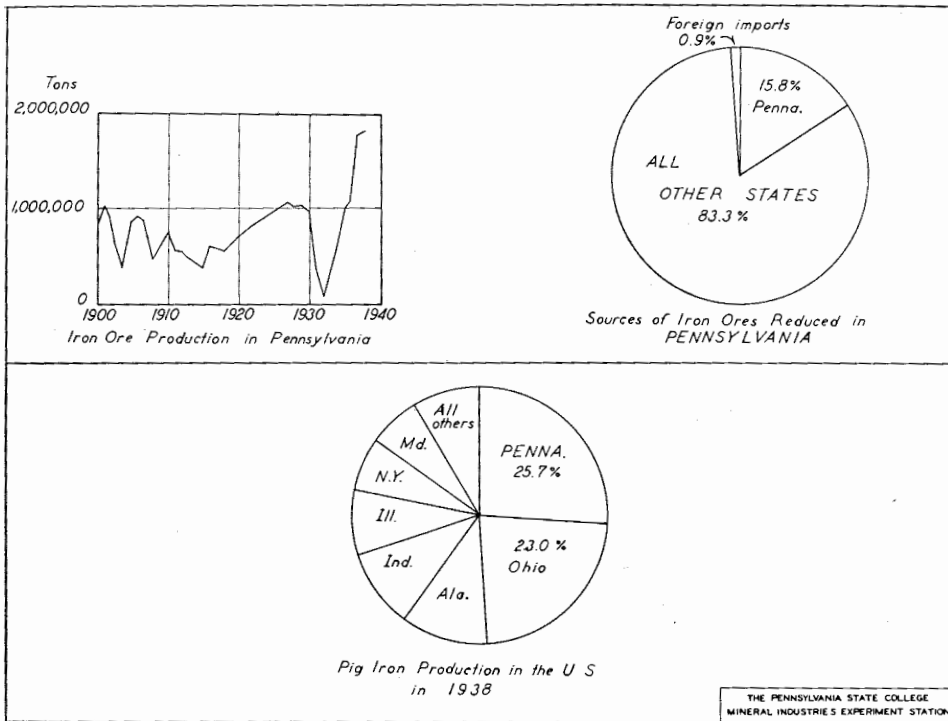


Fig. 14

Pennsylvania at The Economic Crossroads; Her Future at Stake

Discovery, Transport, and Technology
Necessary for Protection Against
Increasing Costs

By A. W. GAUGER
Director of Mineral Industries
Research

Mineral economics is the record of a battle between the growing difficulties of nature on the one hand, and discovery, transport, and technology on the other. Dr. Myers has shown that Pennsylvania's position of supremacy in the mineral industries can no longer be taken for granted. Modified economic and social conditions, the exhaustion of the better and more easily recoverable resources, and changing consumer habits are inexorable factors which must be reckoned with and met by the ingenuity of her people, if the Commonwealth is to retain leadership.

Discovery, the expansion of transport facilities, and technology are the offsetting factors in favor of man in the battle against increasing costs. Technologic advance has been of greatest importance during the past three decades and future progress, it is believed in Pennsylvania, will de-

Present Period Artificial

We are now in a period of artificial business stimulation as a result of the defense program. It is a good time to consider what we are going to do after this program begins to taper off. A statement attributed to Kettering describes research as "what you do in order to find out what you are going to do when you no longer can continue doing what you are doing." This is a trenchant statement of what we need in Pennsylvania now. We need graduate instruction and research in the mineral industries pointing to new products and processes that will keep the wheels of industry turning in the service of humanity after the present emergency is over.

The prosperity of the entire State is in a large measure dependent upon the prosperity of the mineral industries. Inadequate returns to mines, quarries, and mills affect whole communities and result in unfortunate population shifts and capital migrations.

The Experiment Station represents the organized expression of the research spirit of Pennsylvania's School

of Mineral Industries. Its objectives are to seek fundamental knowledge and to establish physical laws that will have wide application; to promote the fullest and most effective utilization of the productive capacity of the mineral industries by seeking new products, new uses, more efficient processes, thus increasing opportunity for employment; to train men for research work; to conserve natural resources; to improve undergraduate instruction; and to enhance the value of extension instruction.

The research program is a necessary function of the College since through it undergraduate and graduate instruction is livened and curiosity and zest for discovery pervade the atmosphere of the classroom. The results of research are carried to the citizens of the Commonwealth through conferences, publications and the many activities of the extension program.

The experiment Station has always cooperated with other state agencies as well as with the mineral industries of the Commonwealth. Such cooperation is mutually beneficial since it fosters a research attitude within the industries and affords the faculty a better knowledge of industrial problems.

The Station is the only research laboratory in Pennsylvania devoted primarily to the study of Pennsylvania minerals and mineral products. This year there are 40 approved research projects.

The mineral industries represent the largest single labor-employing, tax-paying group in the State. They have been on the decline for two decades and are justified in looking to their School for aid on their technical problems. Cooperative effort of the industries, various State departments, and the School will contribute a full share to the prosperity of Pennsylvania and the well-being of its people.

A well-conceived, amply financed research program is our only insurance that Pennsylvania will retain her place in the sun of industrial supremacy. The cost of a day's fighting spent on research would probably solve most of our industrial problems.