Developed and Undeveloped Mineral Resources of Wyoming

DIETZ

The

Wyoming Geological Survey

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BULLETIN XXI

Developed and Undeveloped Mineral Resources of Wyoming

1929


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

THE

Developed and Undeveloped Mineral Resources of Wyoming

A statistical compilation and industrial evaluation on the sundry metallic and non-metallic minerals, chemical salts, fuels and power producers of Wyoming.

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First Edition---1,000 Copies

WYOMING GEOLOGICAL SURVEY
CHEYENNE, WYOMING
1929

Price $1.00 Post Paid

Sheridan, Wyoming
THE MILLS COMPANY
Printers, Stationers, Binders
1929

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Preface

Many books have been published on the mineral resources of Wyoming. Descriptions of these varied deposits appear in over 200 publications of the United States Geological Survey. Maps and reports on these deposits by former state geologists as well as by other scientists who either resided or visited within the State from time to time during the past 105 year period form the titles of 500 additional publications. Manifestly, not all of the information already available on the geology of Wyoming is compressed within the space of present volume.

The chief value of nearly all former reports consists in the wealth of geological information contained therein. In many instances the work has been so thorough that an entire volume is devoted to the geology of a single mineral deposit. On a number of occasions availability of information of this character has vastly accelerated the economic development of our State.

Before starting preparation of present volume, a review of considerable portions of the voluminous literature already accumulated on the geology of Wyoming fell within the purview of prior employment. To correlate and reduce this wide range of information to convenient reference form was one of the original aims of the present compilation.

Many descriptions heretofore prepared on the mineral deposits of Wyoming were written in a phraseology that only the professional geologist could translate. On the other hand, entire reports have been published by specialists that merely covered a local deposition of some simple mineral or chemical salt. For conversion of these lowly raw materials into valuable finished products, industrial reactions sometimes require the consumption of several forms of mineral compounds and potential energizers that occur in huge volumes at different sites within the Wyoming depository.

To connect much of this detached information was also one of the purposes of present commentary. To follow this scheme, the entire mineral depository of Wyoming is, herein, considered simply in the light of a vast storehouse. In succeeding chapters not only do the names of the several ores, non-metallic minerals, raw chemicals, fuels and other sources of basic power appear, but also, in this first inventory, the total stocks and stores of the leading products are expressed in whatever weight, volume, heat or energy, simple ultimate unit it was most convenient to use. As most of the Wyoming stores compare extremely favorable to those known to exist elsewhere, the ranking position of Wyoming in comparison to other states was, likewise, recorded from facts similarly supplied by the United States Geological Survey.

Moreover, the scope of the present systematic investigation made it frequently necessary to point out what reactions are set up when two or more of the mineral, chemical and other latent agencies occurring in Wyoming are brought together in a large industrial manner. Abler efforts conducted within these wider fields should produce a broader mental grasp in regard to the general significance of the Wyoming Mineral Empire.

Some professors of geology may take exception to the abrupt and abbreviated definitions that have been coined, here and there, on the origin, identification, character and extent of some of the leading mineral deposits of Wyoming. Already, geologists know the character and magnitude of the colossal mineral wealth still reposing undisturbed within the Wyoming depository. To arouse the interest of the chemist, metallurgist, engineer, technologist, research worker, industrialist, capitalist and ultimate consumer as well as the student and the reasonably intelligent citizen of the State in these wonderful resources largely accounts for the manner in which this treatise is presented.

In no state is the development and expansion of the mineral industry as important as in Wyoming. Unlike all other states, the major mineral developments are now conducted on public lands that return large royalty payments directly to the State treasury. In the future most opera-

tions will be conducted on similar lands, and largely for this reason, discussions on the continuation and expansion of this most unusual form of revenue enter into some of the ensuing chapters.

No claims are made in regard to the absolute accuracy and completeness of the statements appearing herein. The Wyoming Mineral Empire is of such vast magnitude that many geologists have already devoted the best part of their lives in unravelling its potentialities. Advances in fuel technology, industrial chemistry, mineral fertilizer manufacture, ceramics, electro-metallurgy and other industries typical of Future Wyoming are so complex and all engulfing that scores of specialists could now be occupied in ascertaining the character and number of products that could be fabricated at lower cost directly within the complete and consummate, Mineral Storehouse that largely composes the State of Wyoming as a whole.

C. S. DIETZ.

Cheyenne, Wyoming
December 31, 1928


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PART I—METALLIC ORES

CHAPTER I

PRECIOUS METALS

Gold, Silver, Platinum

GOLD

In 1927 the United States Geological Survey recorded the total production of gold in Wyoming from 1867 to 1924 at $1,237,624.00. Since then, small amounts of gold have been recovered by prospectors developing claims in the Atlantic City District.

Gold associated with silver and other metallic minerals is known to occur at many places in the more mountainous regions of Albany, Big Horn, Carbon, Crook, Fremont, Hot Springs, Johnson, Laramie, Park, Platte, Sublette, Sweetwater and Teton Counties. To date only a small per cent of the recoverable gold has been mined in those Counties.

In common with all western producing states, it is yearly becoming increasingly difficult to interest capital in the development of known gold deposits. The fixed value of $20.67 per ounce for the metal was internationally established in a backward era when wages were less than one-quarter of the high levels prevailing at the present time. Due to mounting production costs, many mines find it impossible to continue operations on a metal value fixed and established long before the World War. Such an unusual economic condition brought havoc to the industry, and from a total of $101,000,000.00 in 1915, gold production in the

United States declined to $52,000,000.00 in 1925. This 50% drop in production has never been paralleled, and no metal mined on a large scale in America ever before suffered so serious a decline within the space of a single decade.

Capital Diverted

Capital that formerly went into gold mining now seeks other outlets for investment. To maintain present standards of living, it is imperative that vastly increasing amounts of commodities like motor fuels, steels, and cements be annually produced in this mechanical and industrial age. The Wyoming reserves of power producers and modern structural materials are of a complete and matchless order. In the past ten year period the search and development of the latter mineral deposits has produced a profound change on the economic structure of the State. At the present time, the annual production of fuels, iron ore, and ceramic materials in Wyoming vastly exceeds the total gold production of America. In years to come, Wyoming mineral production will outstrip national gold production many times over.

In event the gold mining industry will be able to stage a revival, Wyoming can offer some of the most promising ground in the West. For large-scale operations, the flat-lying placers located along the creeks of the Atlantic City District present the greatest potentialities. By crude and wasteful methods, these placer deposits produced one-third of the gold so far recovered in the district. Their successful operation in the future will be solely dependent upon the use of heavy dredging equipment of modern design.

Another placer area reported favorably in the publication of the United States Geological Survey is located along the lower reaches of the Snake River in Teton County. In extent and in gold content, the latter deposits appear to be inferior to those of the Atlantic City District.

SILVER

Statistics of the United States Geological Survey disclose that 70,113 ounces of silver have been produced in Wyoming up to the past year. Much of this silver was

recovered as a by-product in the mining of copper and other metals. The greatest single producer was doubtlessly the old Silver Cliff mine that now adjoins the present city of Lusk. In recent years, the latter property was worked exclusively as a radium mine, and immediately prior to titular litigation concluded three years ago, extremely profitable shipments of radium ore were shipped therefrom.

To date no extensive deposit of rich silver ore has been uncovered in the State. In the old Cliff property at Lusk, silver in the native form was mined, and at Laramie Peak and other localities, both the sulphide (argentite) and the chloride (cerargyrite) have been found. In the big silver producing countries of the world the latter minerals form the richest ore; but depositions so far examined in Wyoming have invariably proven to be of disappointing magnitude. As all Wyoming copper ores are known to carry silver values, it is probable that the silver recoveries of the future will come from deposits primarily mined for their copper content.

PLATINUM

During the past 30 years a number of important discoveries of platinum ore have been made in the mountain ridge lying due west and south of the old mining village of Centennial. Selected assays made under the supervision of the United States Geological Survey found the highest grade sulphide ores of the district to carry more than one ounce of platinum values to the ton of ore. At the present writing, platinum is quoted at $80.00 per ounce and during the past 5 year period the metal has sold as high as $125.00 per ounce, or slightly more than six times the value of pure gold.

Developments to date have unmistakably proven the existence of platinum and other associated metals of extremely high value in the Centennial Ridge of mountains. So far the great difficulty has been to locate a sizeable ore body of proven platinum content. At the present time, a promotion company is expending large sums of money in the development of a huge local dyke, the chemical composition of which doubtlessly approaches the diorite, norite, peridotite rocks of South Africa, in which valuable discov-

eries of platinum metals have been made during the past two or three years. Already, the literature accumulated on the recent African discoveries is of extensive proportions, but so far no metallurgical process has been evolved that will profitably extract platinum values that occur in a finely disseminated form in basic rock primaries.

CHAPTER II

NON-FERROUS METALS

Copper, Lead, Manganese, Tin, Zinc

COPPER

Copper occurs in every mountain range in the State in quantities sufficient to form one of our most important metallic mineral reserves. Up to 1926 the total production of the State amounted to no less than 31,673,137 pounds. That total ranked Wyoming as the twelfth largest copper producer in the Union.

At the present time the Copper-Gold Mining and Milling Syndicate is mining and shipping ores and concentrates from their property located at Tie Siding, in Albany County. The ore consists of metallic copper, as well as the oxides, carbonates and sulphides of the metal. It occurs as impregnations in a porous sand-lime rock along a contact formed by the intrusion of a large diorite dike. During the past spring the company completed a modern rod mill capable of treating 140 tons of ore per day. Seven men are now employed and profitable recoveries of both copper and gold are reported.

In the past three years, car load shipments of copper ore have been made to out-of-state smelters from the Electrolytic Mine situated near Albany, and from the Williams-Luman Mine, near Lysite, as well as from the Sunrise Mine at Hartville. For many years shipments have averaged several hundred tons annually from the latter mine. The copper occurs as lenses of oxidized ore scattered within the large iron body. It carries appreciable values of silver and the recovery of those two metals provide an additional source of revenue for the big iron mining company. The association of iron and copper in commercial quantities is extremely rare and in no other iron mine is copper ore shipped as a by-product at the present time.

Old Encampment Mines

Most of the copper produced in Wyoming was mined in the highly mineralized Encampment District, situated in southern Carbon County. Production peaks were reached twenty years ago, and in the ensuing interval, all of the more promising properties were closed down on account of inefficient management, inadequate financing and other causes. The district still contains the largest bodies of copper ore known in Wyoming. Most of these deposits are low grade in character. In common with other non-ferrous metals, copper has sold at exceedingly low levels ever since the war deflation period. In the past year the price of the metal has noticeably improved and in event of further advances, it is certain that the old Encampment District will be one of the first in which mining activities will again be resumed on a comparatively large scale.

During the past year the newspapers of Wyoming carried accounts of companies opening up new copper properties in the Copper Mountains, Cooney Hills, Centennial, Encampment, Laramie Range, and other widely separated mining districts of the State. So far no field examinations of these newer developments have been made by this office. Without a doubt, much prospecting of a costly character remains to be done before the values of the latter mineralized areas will be made manifest.

If Wyoming can continue its rank among the leading copper producing states of the Union, additional development will soon have to be made of the many and widely varying deposits that occur in nearly all of the major geologic uplifts of the State. These resources are worthy of serious study, regardless of the fact that interest in Wyoming copper mining will probably remain dormant until the price of the metal advances to the levels of the pre-war period.

LEAD

Lead, chiefly in the form of galena, is found near Laramie Peak and Jelm Mountain, Albany County; at Ferris and in the Encampment District, Carbon County; in the Sunshine Basin and in the upper Shoshone region, Park County;

and at Black Buttes, Crook County. At the latter point, some mining was done years ago, but elsewhere in the State the discoveries of lead minerals have so far been of limited extent.

Geological conditions are extremely favorable for the deposition of commercial ore in Wyoming. In leading producing states the largest bodies of ore are found in the Mississippian limestones in the vicinity of ancient granite contacts. Here in Wyoming, wide areas of the granite cores of our great mountain regions are directly overlain with limestones of the Mississippian series. In the big mining states such favorable areas have recently been prospected in an intensified manner with the aid of a drill. In course of time, identical formations will most likely be prospected in a similar way in Wyoming, especially at those more favorable points where small amounts of both lead and zinc minerals have already been observed as outcropping along the surface contacts.

MANGANESE

In recent years a number of manganese deposits have been reported in Wyoming. The most widely known deposit is located at the head of Sheep Creek in Albany County, about 38 miles northeast of Medicine Bow. The ore occurs in two chert beds of the Casper formation, the average width of each being 6 feet. At places, both of the beds are highly impregnated with the manganese oxides, manganite and pyrolusite. Both of these minerals are valuable ores of the metal. Also, associated with these manganese minerals are large tubular crystals of barite, a mineral that is largely consumed by the paint industry.

During the past year, Clarence Metz of Arminto, Wyoming, mailed samples of promising manganese ores to this office. They were identified as manganite and wad minerals of fairly good grade. He reported his local deposit to be of huge extent.

In their publications, former State Geologists reported the occurrence of manganese at widely separated points in Wyoming. So far, few of these depositions have been examined in the field. An inspection made last fall of a Cas-

per Mountain deposit disclosed ore of good grade, but not of sufficient extent to justify mining operations. Further prospecting activities in that highly mineralized area may uncover other ore-bodies of economic merit.

Many Uses for Manganese in Steel Industry

Manganese is a metal absolutely essential in the manufacture of steel. As a deoxidizing, desulphurizing and hardening agent, the steel industry of the United States consumes no less than 750,000 tons of manganese ores annually. By far the greater portion of these ores are imported from foreign countries. To offset that evil and to cause development of known domestic deposits, the Tariff Act of September 22, 1922, finally imposed a greatly increased duty upon further importations of this indispensible metal into the United States, the greatest of all steel manufacturing nations.

Through the protection afforded by the existing Act, domestic proudction of manganese ores increased by leaps and bounds in recent years. As a consequence, exploitation of manganese deposits is finally under way in no less than five of the six states that border Wyoming. As geologic conditions in these surrounding states are similar to Wyoming, it is believed that search and development of our known deposits will not be delayed much longer. The fact that Wyoming contains the best known deposits of iron ore west of the Mississippi should, by itself, demand an exhaustive survey of the manganese resources of the State.

Regardless of the improved ore quotations directly due to the new tariff act, the production of manganese ores in the United States is still woefully inadequate to satisfy domestic demands. This situation has caused this office to receive recent inquiries on the extent of our reserves from manganese committees of the larger mining societies as well as from the President of the American Manganese Producers Association. To meet this newly stimulated interest, samples of ore from every manganese deposit known in the State should be mailed to this office at the earliest practicable date.

So far, neither experiment nor research has developed a substitute for manganese in the manufacture of steel. In event the State can show manganese resources of sizeable extent, one more reason could be offered for the establishment of a steel industry directly within its borders.

TIN

Wyoming is one of the few states in which deposits of tin have been discovered. The known deposits are confined to Nigger Hill, a prominence located in Crook County, near the South Dakota state line.

In specimens recently mailed to this office by an interested County official, cassiterite, the oxide of tin, was identified as one of the leading magmatic minerals in a pegmatitic dike material. If ore similar to the samples can be uncovered in quantity, it is certain that a successful tin mining enterprize would at last become a reality in the United States.

The Wyoming pegmatite deposits extend beyond the state line into the Black Hills of South Dakota. Directly across the boundary a stock selling organization of international scope attempted the exploitation of the South Dakota deposits on a large scale over twenty years ago. Final court proceedings disclosed that stock sales approximated nearly $5,000,000.00, but only a small portion of that huge sum was expended on actual development of the ground.

Exploration operations conducted by the former company found the tin mineral to occur as minor segregates, separated by wide and varying areas of blank and worthless granite rock. Not locating sizeable bodies of uniform ore, interest in magmatic tin deposits has chiefly been of an academic character ever since the date of the South Dakota fiasco.

Most of the tin production of the world is mined from the gravels of both ancient and present-day stream channels. Those gravels are remnants of country rock similar to the tin bearing granites of the Black Hills area. Erosional processes have, likewise, worn down large masses of the latter rocks. As all tin minerals are heavy and readily amenable

to concentration, further search for the metal should be conducted in the known gravel bar bottoms of the locality.

ZINC

Zinc occurs in the iron ores of both the Hartville and Iron Mountain Districts. In each locality the association is too low to warrant separate recoveries of both metals. The zinc contents of these ores are wholly of geologic interest and to date their separation from the predominating iron values has not been attempted on a commercial scale.

The most promising zinc prospect in the State is located in the Silver Crown Mining District of Laramie County. On his Rambler group of claims, John P. Morris has recently sunk a sixty foot shaft into a body of sphalerite ore averaging six feet in width. Assays recently made of the lower workings showed zinc, lead and silver values totaling $7.00 per ton. Development in this Silver Crown property has disclosed a consistent increase of values with depth.

CHAPTER III

IRON ORES

Present Production

Hematite Deposits of Sunrise and Seminole Mountain Districts; Titaniferous, Chrome and Paint Ore Deposits; Prospective Development and Expansion.

In variety, quality and quantity, the iron ore reserves of Wyoming are far superior to those found in any state west of the Mississippi River.

Present Production

Iron ore production in 1926 amounted to the record figure of 630,387 tons, and in 1927, preliminary estimates indicate that 603,334 tons were mined. In recent years production has increased to an extent sufficient to rank Wyoming as the seventh greatest iron mining state of the Union. At the present time, Wyoming's growing prominence as an iron-ore producing state is but slightly appreciated by most of its residents.

Sunrise Mine

So far, all of the iron ore production of the State comes from the Sunrise Mine that is located at Hartville. Its annual output places it among the twenty largest mines of the United States, which country has long been the leading steel producer in the world.

The Sunrise Mine is owned and operated by the Colorado Fuel and Iron Company, who ship the ore to their Pueblo blast furnaces to be reduced. No other iron or steel works of consequence is located in the entire trans-mississippi region and for many years past the highly prosperous Colorado corporation has relied upon the Wyoming ore for its

chief source of supply. Competent geologists have estimated the reserves of high grade hematite of the Sunrise property sufficient to maintain present production schedules for the next 50 to 100 years to come.

Seminole Mountain Hematite Deposits

To meet the increasing markets of the western territory, the time is rapidly approaching when additional deposits of iron ore will have to be developed and mined in Wyoming. One of the more promising of these still undeveloped deposits is located in the Seminole Mountains at a point 40 miles north of Parco. To date, development work on this high grade deposit of hematite ore has not been sufficient to delimit its maximum boundaries. Interest in the deposit will probably remain quiescent until some assurance can be had that the new North and South Railway will extend its line from Casper to Rawlins. As a matter of fact, the local deposit lies on or near the proposed route, and in that favorable position, it would, by itself, provide the bulk of the traffic originating directly along the new line.

TITANIFEROUS IRON ORE

The largest known deposit of titaniferous iron ore in the world is located in Albany County, about 10 miles northwest of Iron Mountain, a station on the Colorado & Southern Railway. Owing to lack of development, no accurate or even approximate estimate of the available tonnage is possible; but considering the surface areas of exposed outcroppings, it can be safely concluded that its quantity totals many millions of tons. Recent advances in chemical and metallurgical technology indicate that more mineral wealth will likely be extracted from the huge Iron Mountain deposit than from any other ore body now known in the State.

Typical analyses show that the ore carries a metallic iron content of 50%. Other contents of the ore are titanium oxide, 23.5%; chromium oxide, 2.5%; and, manganese oxide, 1.5%. In the modern steel industry, all three of the latter directly associated metals are used for making the costly ferro-alloys. In more recent years, an increasing demand has, likewise, arisen for all three of these locally associated

metals for the manufacture of paints, brilliants and enamels typical of the modern period.

By itself, the iron content of the Iron Mountain deposit is sufficient to form a good commercial ore. But in combination with the oxides of titanium, chromium and manganese, the metallurgy of the local deposit proves to be unusually complex. To reduce that extremely refractory ore association, no temperature short of that produced in the electric furnace will suffice. In other countries, similar deposits are now being successfully exploited by advanced electro-metallurgical processes. For the separation and reduction of all the valuable metals contained in the Iron Mountain deposit, an immense amount of electric current will, likewise, have to be consumed. At the present time, the North Platte River and Iron Mountain problems are entirely synonymous. Manifestly, before the dual reclamation and hydro-electric potentialities of the local river valley are developed, no volume of energy will be available to reduce the Iron Mountain ores on an adequate scale.

CHROME IRON ORE

Among the more unusual iron ore formations of Wyoming are two deposits of chrome iron ore located on Casper Mountain at short distances south of the cities of Casper and Glenrock. A recent field examination showed that the deposit nearest Casper occurs in a diabasic dike that maintains a fairly uniform width for a distance of 5,000 feet. At places the dike rock contains localized lenses that are saturated with fine globular grains of black chromite mineral about the size of bird shot. The texture clearly discloses that the ore is a magmatic segregation within the basic dike itself.

While the dike outcrops over a wide area, nevertheless, its composition is so variable that only minor portions thereof are sufficiently mineralized to form commercial ore bodies. The enriched lenses apparently occupy from 4 to 10% of the total material and all of them gradually blend into the parent magma after their thickness exceed a width ranging from 6 to 10 feet. The mining of these localized

bodies would not prove expensive, but before development work is started, the extent of the richer segregates should be ascertained by trenching and other prospecting operations.

Assays of the more promising ore material recently made disclosed chrome oxide contents of 22½%. As the distant reduction works require 45% ore, it is evident that the successful exploitation of the local deposit will involve both mining and milling operations. The chrome can be economically separated from the gangue material by the electro-magnetic process, and if concentrated to the requisite 45% grade, a price close to $25.00 per ton can be received for the shipping mineral. This valuation is ten times higher than that generally placed on our best hematite ores. If mined in quantity, its shipment to the nearest chrome reduction works at Niagara Falls should still prove profitable. As matters now stand, exploitation of the chrome deposits will doubtlessly await local development of the hydro-electric potentialities of the North Platte River. As soon as that day arrives, ruinous freight rates to a distant reduction works would be entirely eliminated.

PAINT ORE

Near Rawlins, Douglas, Hartville, and elsewhere in the State, huge deposits of iron ore, generally inferior to the shipping product, but still serviceable for the manufacture of mineral pigments, occur. From these undeveloped deposits, beautiful shades of red, brown and yellow ochres can be obtained in limitless quantities. As our infant ceramic industry expands, a domestic demand will arise for these pigments in the manufacture of additional color lines of ornamental bricks, tiles, asbestos shingles and other building products typical of modern Wyoming.

In the Mineral Pigment chapter of this volume further remarks are filed on the Rawlins Paint Ore Deposit.

PROSPECTIVE DEVELOPMENT AND EXPANSION

Innumerable technical and economic factors of a widely varying scope are constantly at work in rapidly bringing the great iron ore reserves of Wyoming to the forefront.

Because of the even distribution of heat and its absolute control, the electric furnace is rapidly supplanting the fuel fired furnace for smelting iron and the manufacture of steel. In 1926, the production of steel in America by the electric process totaled 651,723 tons. That total was over 21 times as large as the 1913 production. For the reduction of the deposit at Iron Mountain, as well as other refractory deposits, the revolutionary advances now under way in the electro-metallurgical industry will doubtlessly play an important part. At the present time, plans that call for the complete development of the hydro-electrical resources of the greatest river basins in Wyoming are in the hands of technically trained statesmen fully qualified to protect the interests of the State at large.

In the last 15 or 20 years the grade of mine runs in the Lake Superior district, which has heretofore supplied 85% of American production, has been constantly declining. To maintain the acceptable standards of former years, methods of beneficiation which are ever becoming more elaborate, are used to compensate for the actual declines in quality. For mining the ores of Wyoming, such costly supplemental processes of production would be entirely eliminated. As time goes on, our reserves of high grade ores will become increasingly important. In years to come, they will receive due consideration on the part of the iron-masters of America.

The tremendous significance of the rapid depletion of the eastern ores has not yet fully impressed the American people. China, Japan, Brazil and India, with immense quantities of iron ore, cheap labor, and water power, are already reducing their ores by the electric furnace, largely with the aid of American financial underwriting. With the falling off of high grade eastern ores and by local development of hydro-electric power, vast deposits of refractory ores which cannot be handled in an ordinary blast furnace, will also be successfully exploited right here in Wyoming. The electric, thermostatically controlled, product is markedly superior to that of the standard blast furnace. Heretofore, the argument against the establishment of a steel industry in Wyo-

ming was the lack of good coking coals within the State. The high temperature electric furnace, in lieu of deposits of coking coals, must solve Wyoming's problem in regard to the future industrialization of her complete iron and steel resources.

In addition to huge deposits of high grade ores, limestone for fluxing material is convenient to each iron deposit in exhaustless amounts. At the present time, all adjoining states rely on Wyoming for the almost chemically pure limestone that they consume in their sugar refining operations. For the manufacture of modern steels, the titaniferous, manganiferous and chrome bearing ores of Wyoming would supply three of the most important metals consumed in the directly associated ferro-alloy industry. For the establishment of a steel industry, the WYOMING MINERAL EMPIRE is incredibly rich in a diversity of requisite raw materials and undeveloped hydro-electric potentialities.

Geographically, the position of the Wyoming ore reserves is yearly becoming of more importance. The consumption of Western made pig iron in Western industry and construction is growing much more rapidly than the output. The development of diversified iron consuming industries throughout the trans-mississippi area will soon necessitate more furnaces to take care of the rapidly growing local trade. For the elimination of the "Pittsburgh Plus" handicap, over the wider area of America, no raw materials are more important or occupy a more strategic location than the iron ore reserves of Wyoming. Due to the superior character and extent of these basic raw materials, Wyoming, in course of time, must lead the van of Western commerce and industry.

CHAPTER IV

RARE METALS

Radium, Uranium, Vanadium

It is not generally known that Wyoming is one of the three states in which radium ore has been mined in a highly profitable manner. Within the brief eight month interval between December, 1918, and September, 1919, the Lambert Ore Company and the Lorimer Minerals Corporation shipped from the old Silver Cliff Mine, that is situated within the city of Lusk, five car loads of radium ore, for which the total sum of $33,857.48 was received.

As soon as the news of these extremely profitable shipments had become known, the titles of the ore producing companies were attacked by hostile interests. In the ensuing litigation, all mining operations were suspended by an order from the District Court. Litigation of a more disastrous and more unseasonable character was never before instituted in this State. For at the time the original order was issued, 95% of the radium production of the world was being mined in a free and unmolested manner in Wyoming, Colorado and Utah. However, five years later, when the titles of the original operating companies were finally affirmed, all of the radium supply of the world happened to be extracted from a single deposit that was discovered in the highly mineralized Katanga area of the Belgian Congo. Moreover, the recent foreign discovery was not made until all operations at the Lusk property had already been suspended for a period of two years of elapsed litigation.

Africa's Rich Deposit

The radium content of the equatorial African deposit is ten times greater than the richest of known American ore bodies. As the extremely high cost of radium salts is entirely due to the necessity of mining and treating many

thousands of tons of ore before a fraction of an ounce of the metal can be recovered, the owners of the rich foreign discovery lost no time in reducing the price of radium from $120,000.00 to $70,000.00 per gram. At the latter controlled figure, it is quite impossible to exploit even the richest deposits of America on a profitable basis. As a consequence, all operations of the recent American radium monopoly will probably remain in a state of quiescence at least until some news can be had that the sensational African deposit is approaching the verge of exhaustion.

Had the highly unseasonable litigation at Lusk been delayed even a few months, Wyoming would have doubtlessly become the greatest producer of radium in America. In magnitude and quality, no deposit in the United States is superior to the Lusk ore-body. In other producing states the radium minerals occur as minor impregnations in unaltered sandstones and the continual exploration required for the search of such erratic and widely separated deposits is an extremely costly procedure. At Lusk the radium bearing mineral, uranophane, appears as a yellowish green coating or incrustation on a quartzite gangue formation which completely fills a vertical fault zone that averages 20 feet in width along a north and south line for a distance of 1,700 feet. More than 40 years ago this comparatively large deposit of uniform ore material was opened as a silver and copper property, and for many years afterward both of those metals were recovered therefrom with varying degrees of success. In mining ore worth a few dollars a ton, the old owners discarded on their refuse dumps radium bearing minerals that their successors later started to salvage and sell for more than $6,000.00 per car load. Up to the date of the African discovery which caused the complete disaster to the American radium industry, the value of radium ore discarded on the dumps of the old mine could be conservatively appraised at not less than one-half million dollars.

Old Miners Threw Ore Away

Inasmuch as the radium element was not known or isolated until many years after the mining property at Lusk

was opened, no one can blame the old miners for throwing away rock that had no apparent value until years after all of their operations had ceased. But waiting 20 years after radium had been widely proclaimed as the most costly substance ever known was indeed a highly belated occasion to begin the development of a rich ore deposition located almost within the shadows of the Court House of a Wyoming County Seat. As a matter of fact, for many years before and after science had isolated radium as a separate element, residents of the city almost daily observed the rather ordinary looking incrustations that coated the dump rock of the local mine. Finally, one day a more than usual visitor came to town, and wholly at his own expense a costly chemical analysis was made of the strangely appearing clay-like mineral. Inside of a few months the cost of that analysis was returned a thousand fold, and had the over-curious stranger been permitted to carry on in the even tenor of his way, another princely fortune would have been garnered from one of the more unusual mineral deposits of Wyoming within a comparatively brief interval of time.

In all probability, many years will pass before an equally amazing mineral deposit will be discovered to lie directly within the corporate limits of one of the more modern municipalities of Wyoming. At the present time, the untrodden fastnesses of our larger mountain ranges doubtlessly offer wider and more promising territory to conduct tests and explorations of a similar scientific trend.

Already, other deposits of radium minerals have been announced in Wyoming. Since the Lusk exploitation Mr. David Crockett discovered radium bearing ore on his mineral holdings situated on Casper Mountain, about 8 miles south of Casper. His radium values appear in carnotite, which is largely a vanadate of uranium and potassium. Formerly, that Colorado type of mineral supplied all of the radium of the world and upon the recoveries yielded therefrom, the market of the rare metal was accordingly governed. Unfortunately, complete cessation and extinguishment of domestic carnotite production immediately followed the recent discoveries of curite, bequeralite, soddyite and

other alteration deposits of pitchblende in the Belgian Congo. The radium content of all of these new minerals is generally recognized as many times greater than that of carnotite. However, during the past year some rumors have been afloat in regard to the approaching exhaustion of the Congo ore deposits.

URANIUM AND VANADIUM

The uranium and vanadium contents of the uranophane and carnotite deposits so far exploited in Wyoming have seldom exceeded 3 per cent. At the present time, higher grade ores are required to reduce successfully uranium and vanadium minerals to the metallic form.

neighboring states. If tests proved otherwise, the nearly chemical pure limestones of Wyoming would not be exported to the distant sugar refineries of the Rocky Mountain region, nor would adjoining states be compelled to rely upon our granite rock to ballast their long railway mileages. At present the lime and granite businesses gross more than a half million dollars annually in Wyoming.

Other signs point to increasing expansion in this division of the mineral industry. All new brick works fall within this category, and unless Wyoming had the best natural cement-mix, an outside point would have been selected for the new mill recently completed at Laramie at a cost of $2,000,000.

In this division, gypsum generally commands the highest value throughout the nation. Naturally, the gypsum deposits of Wyoming are the greatest known. By purchases completed last summer, both giant gypsum corporations of United States are now established in Wyoming. For their manufacturing operations, exhaustless supplies of raw material are directly available at the mill sites. The export business in finished products of these new works adds appreciable wealth to this State. At present as well as in the future, other states will rely on the vast deposits of Wyoming as their source of supply for gypsum.

Like preceding divisions, the huge stocks and reserves of the Wyoming storehouse are now ready to meet all expansion demands that can possibly arise within the third division of the national mineral industry.

Non-Ferrous Metals

Of the 20 leading mineral products of the nation only copper, lead, zinc, gold, silver, and aluminum remain for description. The recovery of these metals constitute the fourth and final division of the mineral industry as hereinbefore classified.

According to evaluations recorded on prior summary, the mining of these six non-ferrous ores form only 9% of present activities of the mineral industry as organized today. Manifestly, leadership in this comparatively inconsequential field does not concern the future welfare of Wyo-

ming nearly so much as continued growth and expansion within the vastly more important divisions of the mineral industry. Nevertheless, without the occurrence of ores for all six preceding metals, full recognition of Wyoming as a complete mineral depository would not be possible.

In Wyoming the mining of some of these ores in paying quantities even antedated coal mining. In the earlier days, complete statistics were not collected. Regardless of these discrepancies, Government publications record the total gold production in Wyoming at $1,237,624. Total silver production of the State is similarly recorded at 70,113 ounces, and copper, at 31,637,137 pounds. The records for silver are, likewise, incomplete. At present, exceptionally favorable gold and copper properties are known to await development in Wyoming.

Promising deposits of both lead and zinc occur at widely distributed points within the State. So far none of these deposits have been exploited. Their similar geological relationships to recent discoveries that are now being worked elsewhere in the United States were commented upon in previous chapters.

So far Wyoming has not produced any ores of aluminum, the twentieth and last product covered by this summary. In United States Geological Survey Bulletin, No. 512, the aluminum oxide content of the leucite deposits is estimated at no less than 197,300,000 tons. Extraction of this chemically pure material, however, awaits the establishment of a potash operation in the locality. Many additional tons of alumina would, likewise, be yielded from the soluble ammonia alum deposits if mineral fertilizer plants locate in same region. At present, production of aluminum ores, is insufficient for national requirements. In time Wyoming may materially lessen this serious shortage.

The metallic ore wealth of Wyoming has been grossly exaggerated from time to time. Some learned critics believe that the exploitation of these ores should constitute the entire mineral industry of Wyoming. Inexorable economic laws constantly work against their enthusiasm. Today, coal, gasoline and other products, typical of modern

Wyoming, cost twice as much as they did in the pre-war period. On the other hand, most of preceding metals can be purchased either exactly at or even below the costs that prevailed when the American wage scale was not half as high as present record. At the odds offered, huge aggregations of capital will continue to display most of their interest in the non-metallic resources of Wyoming.

A Self-Contained State

Aside from iron ore, which was classified in a prior division, metal mining does not form one per cent of the Wyoming mineral industry. At the best it will probably never exceed the 9% level now maintained by the nation at large. In Wyoming more known undeveloped mineral wealth is concentrated than in any other state. More important than this fact are the further circumstances that the twenty leading products of the United States either are or will be the twenty leading products of the Sovereign State of Wyoming. Manifestly, no reason exists for the minerals at end of the list to be as economically important as those at the head. As a matter of fact, production of the twentieth mineral totals only 2% of the nation's coal production.

The concentration of the mineral wealth of the nation within the confines of a single state is a factor that will profoundly influence industrial development of the future. Today, states that are industrialized in an intensified manner are largely dependent on outside sources for their basic raw materials. To use an engineering phrase, Wyoming is the one "Self-Contained State" in the industrial sense of the word.

The Pennsylvania of the West

As yet, only the slogan-maker has attempted to express the Wyoming Potential in a comparative sense. Some years back he called—"Wyoming the Pennsylvania of the West."

For some states no comparisons are possible. However, following contrasts are recorded below:

Pennsylvania has always led in coal mining and solely for this reason she is the only state that annually maintains a mineral production in excess of one billion dollars.

Today, total coal reserves in Pennsylvania are recorded at 133,000,000,000 tons. In the One Trillion Ton Reserve of Wyoming a potential force over seven times as great remains. For huge industrial requirements, colossal tonnages of Wyoming deposits can be steamshoveled at a small fraction of the mining costs in the East.

The continuous hydro-electrical potential of Pennsylvania is recorded at 313,000 horse-power. In this modern strength test, Wyoming is only 2¼ times as powerful as her smaller sister.

Oil and gas were first discovered in Pennsylvania. As a matter of fact, at one time it was generally conceded that these chemical curiosities could never be discovered outside of Pennsylvania. Today, Pennsylvania's oil production meets 10% of her requirements. In Wyoming, production exceeds domestic demands by 1,000%. Same relativity of strength could be recorded on gas production. In other words, pipelines now go into Pennsylvania. In Wyoming, they go out.

For some time steel has served as the index of civilization. For many years Pennsylvania has led in the production of this basic commodity. For the manufacture of her steel, Pennsylvania mines but 4% of the iron ore consumed by her blast furnaces. For many years Wyoming has shipped 100% of her iron ore production to blast furnaces outside of the State.

Perhaps, the next work of the slogan-maker will be—"Pennsylvania, the Wyoming of the East."

CHAPTER VII

WYOMING HAS SCENERY AND CLIMATE

Continental Divide—Inspiring Scenery—Invigorating Climate—Over-night Accessibility—Doctor Sun—Efficiency Engineering.

Many varieties of scenery abound in Wyoming. Beginning at the extreme western boundary of the famed Yellowstone Park, the main chain of the Rocky Mountains crosses the entire width of the State in a southeasterly direction. As Wyoming thus forms a central vertebra of the backbone of the nation, only the more prominent type of mountain scenery is reviewed herein.

Continental Divide

No part of the Continental Divide is more widely known than the Wyoming sector. In covered wagon days the Mormon and Oregon pioneers and the California goldseekers selected the lower passes of Wyoming for their slow-moving caravans to cross the Great Divide. Later, when the first transcontinental railway system was constructed, one of these old trails was located as the most favorable and direct route. In more recent years the Wyoming trails of the pioneers were similarly chosen for the Lincoln Highway, as well as for the establishment of the Transcontinental Air Mail System. In the scenic mountains of Wyoming all of these pioneer, sea-to-sea highways climb to their highest elevations.

For scenery, the Wyoming sector of the Continental Divide is even more famous. Fifty-six years ago, when the National Government decided to preserve natural wonders from settlement or mutilation of any kind, more than 3,000 square miles of the Great Divide region of Wyoming was set aside as the Yellowstone National Park. Since then, the

fame of this first and still largest park wonderland of the Government has spread to all corners of the world.

In area, barely more than 10% of the Wyoming sector of the Continental Divide is included within the boundaries of the Yellowstone National Park. To presume that all of the scenery of the Continental Divide is in the park is a mistake quite often made. In the park the highest promontories seldom reach an elevation of 10,000 feet, but elsewhere in Wyoming, no less than eleven peaks are over 13,000 feet in height. By far, these latter eminences offer the most inspiring scenery of the entire Rocky Mountain region.

Inspiring Scenery

For an imposing display of grandeur nothing can surpass the huge precipitous monoliths of solid granite that form the highest mountains in Wyoming. From off the towering, awe-inspiring flanks of these star-seeking pinnacles, crystal clear streamlets fed by perpetual glaciers cascade in most abrupt manner to more sedate amphitheaters on which picture-bookish hills and downs of emerald are mirrored in myriads of lakes of turquoise blue enamel. Further below, these mellifluous traceries of intricate lace-work commonly dissolve into larger lakes or more prosaic channels that form the headwaters of the great river systems of America. Thus in the later channels, the original drop of water returns to the distant ocean from whence it departed in the form of aqueos vapor a few months or in some instances, even centuries before its estoppel and consequent recondensation, congealment and final dissipation on the cloud-scraping heights that form the snow-adorned skyline of Wyoming. In desolate glacial pockets of the more majestic mountain massifs, remnants of centuries old snowfields bear impressive witness to the never ending character of these constantly recurring processes of vaporization and liquefaction that are so vital for the sustentation of all forms of life on the Continent as a whole.

In Wyoming the summit slopes, couloirs and castlements of many of the higher peaks still remain unclimbed. The final conquest of those silent and sombre bleak-heights

will continue to tax the resources of the most agile and intrepid cragsman for many years to come. In the meanwhile, the amateur Alpinist will find thrills and spills a plenty in merely negotiating the lesser promontories that laterally flank the higher pinnacles.

Invigorating Climate

In the cleaner, purer, drier and thinner air that envelopes the vast mountain fastnesses and surrounding highland plains of Wyoming, the radiation of the Sun penetrates in the original undissipated form. Naturally, such undiluted vitalizing activations produce a climate of matchless vigor and salubrity. Moreover, to escape the torrid and stifling heat waves that engulf great metropolitan centers, increasingly larger numbers of delighted and affable urbane visitors have learned the wisdom of annually seeking the cool retreats of the incomparably scenic Rockies that are at last crossed by every form of modern highway in Wyoming. Formerly, such a journey was a serious undertaking, but on a typical summer day of present era, the car of Mr. and Mrs. America is parked on Lincoln Highway, the Main Street of the Nation, directly within the refreshing shadows of a snowcapped mountain range.

Over-night Accessibility

Lastly, by the recent addition of multi-passenger carrying planes on the air mail line, the executive and businessman of America no longer needs to swelter through an entire summer season. This latest eighteen hour service from New York permits week-end visits to the snowfields that everlastingly cap the topmost strongholds of the supremely majestic mountain ranges of Wyoming. Even a twenty-four hour stay amidst the sheathing ozone and sunshine of those lofty altitudes will return the distant visitor with reserves of dash and vim ample to start the week afresh in the far less invigorating clime of his lowland domicile.

Old Doc Sun In Limelight Once More

According to advertising literature recently circulated throughout the nation by the *largest life insurance company, the world's greatest physician is Dr. Sun, distant 92,000,000 miles away from his ever more grateful patients.

The foregoing announcement never was news in Wyoming. Many million years ago Old Doc Sun built up aggregations of bone and brawn in Wyoming on scales of immensities never surpassed within the history of his terrestrial satellite. As a result, skeletal remains of dinosaurs exhumed from Wyoming rock tombs still form the biggest displays in the natural history museums of the world.

To assume that Dr. Sun ceased work after the twilight of familia dinosauria would be a big mistake. From decay of floral life, a trillion tons of coal offer fossilized evidence of his subsequent activities in Wyoming.

At present, the degree of Solar receptivity is barely less miraculous. In Wyoming the Solar Engine puts more sugar in the beet and also grows a crop of corn within the shortest period. In more rarefied atmospheres, where herds and flocks graze, daily poundage increases in beef and wool, likewise, break all records extant.

Solar therapeutics is the latest recruit in medical science. Until advent of the World War this newcomer had no accepted standing. Not until past year or two did corporations advise the nation to absorb and store up more health direct from the Sun. Get more sunshine and thereby build up the bloodstream with a larger supply of calcium, iron and phosphorous, is the clarion cry of the day. Should any one doubt the authority contained in present advertisements, a visit to Wyoming should suffice. At sites where bio-chemical processes reached their maximum degree of development, millions of tons of calcium, iron and phosphorous rock bear ample witness of the intensity of Solar radiations once received in Wyoming.

Future Efficiency Engineering Practice

Regardless of the great variety of records already broken, one scientist has yet failed to make his appearance

*Metropolitan Life Insurance Company.

in Wyoming. Manifestly, the foregoing line refers to the much heralded efficiency engineer of the day.

In the fogless, dustless, smokeless, rarefied atmosphere of Wyoming, the bombardment of the ultra-violet and actinic rays of the Solar Dynamo is carried on with the lowest possible degree of interference. Recent scientific advancements have maintained that these are the rays that, among other things, spell death to bacteria and germs, increase red corpuscles in the anemic, strengthen unused and atrophied muscles in the indolent, flood the chronic pessimist with optimism, and also, stimulate entire schools of manual and mental workers to higher purposes of endeavor.

As yet only the medic and bacteriologist have endorsed the claims set forth in preceding paragraph. As soon as the efficiency engineer invades this virgin field, his calibrating devices may register exponentials for the human engine sufficiently high to cause a general exodus of industry from shivering or sweltering fog-laden climes to the more equable atmosphere that envelopes the Wyoming Wonderland with ozone and sunshine of purest ray serene.


STATE OF WYOMING
1933
GEOLOGICAL SURVEY

Appendix

Statistical Tabulations

Appendix

STATISTICAL TABULATIONS

TABLE I

A BILLION DOLLAR INDUSTRY

During past 23 year period, U. S. Geological Survey and the Bureau of Mines have been busily engaged in collecting facts in regard to activities of the mineral industry of America. Their reports on the total mineral production of Wyoming for all years covered by the period of 1905 to 1926, inclusive, follow below:

Year	Production	Year	Production
1905	$ 8,657,202	1917	$ 29,547,428
1906	9,063,849	1918	42,595,812
1907	10,671,574	1919	41,097,209
1908	9,453,341	1920	82,687,897
1909	15,483,886	1921	51,365,150
1910	16,809,030	1922	58,529,284
1911	11,483,377	1923	77,664,547
1912	13,374,088	1924	75,494,166
1913	13,682,091	1925	78,754,915
1914	12,417,752	1926	78,988,066
1915	12,708,238		
1916	19,666,988	Total	$770,195,890

As yet, the Federal agencies have not concluded their detailed canvasses on Wyoming mineral production for the years of 1927 and 1928. As soon as their reports are available an additional sum of $150,000,000 will be accredited to past production.

Coal mining began when the Union Pacific Railroad entered Wyoming 60 years ago. The production of coal and other minerals in Wyoming before the statistical year of 1905 can be conservatively evaluated at $100,000,000.

Already, the mineral industry of Wyoming has safely passed the billion dollar mark. The total is quite impressive. In magnitude it happens to surpass the monetary value of the entire State of Wyoming, that is, if full reliance is placed on the latest census evaluations.

Of course most of this created wealth was exported to other states as well as to distant foreign nations. Before leaving Wyoming, every dollar thereof materially augmented the revenues of the State.

In Wyoming the industry is still in its swaddling clothes. All things considered, the billion dollar enterprise has merely laid a foundation in Wyoming. On present structure a towering industry will be erected in the course of time.

TABLE II

WYOMING'S LEADING INDUSTRY

Not all citizens realize that the production of minerals is the most important industry of Wyoming. Heretofore, no complete comparisons have been made of the two major industries of this State. The totals, as recorded in the latest bulletins of the Bureau of Mines and the State Commissioner of Agriculture, are respectively set forth in the parallel columns appearing below:

STATE OF WYOMING

Agricultural Production for 1926		Mineral Production for 1926		
Products	Value	Product	Quantity	Value
All cereal, forage, vegetable and fruit crops	$30,444,000	Clay Products	--------	$ *
		Clay, raw—tons	4,409	** 96,853
Total of all livestock production (excluding wool)	25,907,000	Coal, tons	6,512,288	17,827,000
		Gypsum	*	*
		Iron Ore, tons	630,387	*
Wool production	6,925,000	Lime, tons	*	*
		Mineral Water, Gals.	***	***
Eggs and Poultry Products	3,996,157	Nat. Gas, M. C. Ft.	46,567,000	4,669,000
Dairy Products	4,645,431	Nat. Gas Gasoline, Gals.	40,625,000	3,934,000
		Petroleum, Bbls.	25,776,000	51,020,000
		Phosphate Rock, tons	4,464	29,000
		Sand and Gravel, tons	941,292	139,273
		Sodium Salts	*	*
		Stone, tons	153,940	316,463
		Miscellaneous		1,053,330
Grand Totals	$71,917,588			$78,988,066
		Mineral Production Excess		$ 7,070,478

*Value included under "Miscellaneous."

**Value not included in total value for State.

***No canvass.

In nearly all remaining states that form this great agricultural nation, farm product values usually exceed mineral products from 2 to 100 times. Nowhere else in the United States are the people more dependent on the mineral industry than here in Wyoming.

TABLE III

WYOMING LEADS IN MINERAL PRODUCTION PER CAPITA

While Wyoming is the second smallest state in population, nevertheless the value of her annual mineral production is only exceeded by the 18 far more populous states listed below in their ranking orders:

Rank	State	Mineral Production for 1925	Mineral Production per capita (1920 pop.)
	Leading Fuel Producing States		
1	Pennsylvania	$867,196,142	$ 99
2	Oklahoma	501,767,118	247
3	California	496,923,376	145
4	Texas	351,211,629	75
5	West Virginia	333,527,697	228
6	Ohio	247,506,588	43
7	Illinois	231,658,604	36
8	Kansas	142,944,214	124
9	Kentucky	131,370,840	54
	Leading Metallic Mineral Producing States		
10	Michigan	122,212,254	33
11	Arizona	114,202,670	342
12	Indiana	111,833,732	38
13	Minnesota	110,252,956	46
14	New York	102,035,557	10
15	Utah	100,275,442	281
16	Missouri	92,548,473	27
17	Arkansas	87,185,532	50
18	Montana	79,261,284	144
19	**Wyoming**	78,754,915	$405.11

An analysis of this tabulation plainly discloses that in none of the great mining states of America is mineral development being carried on to the degree of individual intensity already attained in Wyoming. As indicated therein, the $405.11 per capita production figure of Wyoming is a record so far unapproached by any of the great mining states of the Union. In reality, this record figure equals almost eight times the $53.00 mineral production per capita of the United States.

It will be noted that all of the nine great mineral producing states of America are its giant coal or oil and gas producers. In some of those major states, like Pennsylvania, where oil was first discovered, only reserves of coal remain of comparative importance. But in those two states, of the nine leaders that still have important reserves of all three minerals common to Wyoming, similar economic conditions prevail. In other words, among the big nine producing states, the Wyoming per capita record is only faintly approached by Oklahoma and West Virginia, or the two states that, likewise possess all three of the vastly important deposits typical of Wyoming.

TABLE IV

WYOMING LEADS ALL STATES IN UNDEVELOPED MINERAL WEALTH

Three years ago, A. B. Bartlett, former State Geologist, completed an appraisal of the undeveloped mineral wealth of Wyoming. His totals appear in the following summary:

Coal	1,076,620,100,000 Tons	@ $0.10	$107,682,010,000
Oil	553,500,000 Bbls.	2.00	1,107,000,000
Oil Shale	20,000,000,000 Bbls.	2.00	40,000,000,000
Gas	7,000,000,000,000 Cu. Ft.	0.10	700,000,000
Iron Ore	500,000,000 Tons	1.00	500,000,000
Phosphates	200,000,000 Tons	1.00	200,000,000
Potash and Alumina	1,973,000,000 Tons	0.20	394,700,000
Metallic Minerals—Gold, Silver, Copper, etc., estimated			
Other Minerals, Asbestos, Mica, Platinum, Graphite, Sulphur, Sodas, Gypsum, Clays, Building Stone, Limestone, etc., estimated			1,000,000,000
Total			$151,634,960,000

No state can approach the colossal total of dormant mineral wealth contained within the Wyoming confines. Economically speaking, if a division is made of the total valuation, the wealth of each inhabitant in undeveloped mineral reserves would be found to be far over a half million dollars per said inhabitant. No similar area can possibly offer a margin so high, wide and handsome for future development. In reality, a slight increase in mineral production would suffice to advance Wyoming ahead of all states in actual per capita wealth, in lieu of the second ranking position its extremely favored citizens already enjoy in accordance with the official calculations recently established by the Federal Census Bureau.

Apparently, the day is rapidly approaching when no state will surpass the Wyoming, per capita, ratings in either developed or undeveloped wealth. Manifestly, to reach both foregoing goals no state has the wealth potential that still reposes undisturbed below the terra firma of Wyoming.

TABLE V

*USEFUL MINERALS OF WYOMING

Agate (Moss). Carbon County, has been mined near Sweetwater River; common in other localities. Fremont County, head of Long Creek and on Sage Hen Creek, north of Granite Mountains. Natrona County, on Sage Hen Creek, northeast of Granite Mountains. Platte County, Wilde and Deercorn mine, 2 miles northwest of Guernsey, moss agate, also red and banded; mined intermittently.

Allanite. Albany County, near Albany station. Occurs near line between secs. 3 and 10, T. 14 N., R. 78 W., in pegmatite.

Anglesite. (lead sulphate). Carbon County, at Ferris, with galena, cerusite, and quartz.

Argentite (silver sulphide). Laramie County, with other ores, Laramie Peak.

Asbestos (chiefly chrysotile). Albany County, Laramie Range. Carbon County, in Seminole Mountains. Converse County, occurs 10 miles south of Glenrock. Crook County, Black Hills. Natrona County, mined on Casper Mountain, 8 miles south of Casper, and on Smith Creek, 20 miles southeast of Casper; fair quality; associated with serpentine; 2 mills erected in 1910; small production.

Asphalt. Fremont County, occurs 4 miles northeast of Fort Washakie at a depth of 1,500 feet in wells drilled for oil, and in nearly all of the oil districts as maltha or brea. Big Horn County, west slope of Bighorn Mountains in secs. 28, 29, 32, 33, T. 52 N., R. 89 W.

Azurite (blue carbonate of copper). Albany County, Rambler and Blanche mines at Holmes, Grand Encampment district. Carbon County, occurs but not mined in Seminole district. Crook County, Warren's Peak. Johnson County, Bighorn Mountains. Platte and Goshen Counties, in Hartville Uplift in many prospects; mined in Copper Belt mines.

Barite (heavy spar). Albany County, Medicine Bow Mountains; not mined. Crook County, Black Hills. Park County, at Kirwin.

Bentonite (medicinal or paper clay). Occurs in Albany, Big Horn, Carbon, Converse, Crook, Fremont, Hot Springs, Johnson, Natrona, Park, Sheridan and Weston Counties; used for weighting paper, as an adulterant, for hoof packing, and in the manufacture of antiphlogistine. Albany County, extensive deposits well developed on Rock Creek in eastern part of county; deposits also occur respectively at 8 and 20 miles southwest of Laramie; has been shipped from Rock Creek and Laramie Basin. Big Horn County, thick deposits in northern part of Bighorn Basin, near Hartman and the Montana boundary. Weston County, near Newcastle; has been shipped from Clay Spur and Newcastle. In Hot Springs County it occurs in beds 3 feet thick.

*Taken from Bulletin 624 of the United States Geological Survey on "Useful Minerals of the United States," 1917, by Frank C. Schrader, Ralph W. Stone, and Samuel Sanford.

Bismuth. See Bismuthinite and Bismutite.

Bismuthinite. Albany County, occurs near Cummings City; not mined.

Bismutite. Albany County, has been mined on Jelm Mountain.

Bornite (purple copper ore). Carbon County, mined at Encampment district. Platte County, formerly mined about Hartville.

Brown iron ore (limonite). Albany County, occurs at Jelm mines. Converse County, near Douglas. Fremont County, on Little Popo Agie Creek; not mined.

Cassiterite. Crook County. Stream tin has been found sparingly at various times in the gulches around Nigger Hill, S. Dak., on State line.

Cement material (Portland). Albany County, 15 feet of pure marl in Niobrara formation, 8 miles southwest of Laramie. Laramie County, Niobrara and Minnekahta limestones and Graneros shale member of the Benton, near Cheyenne. Weston County, near Newcastle. Not used.

Cerargyrite (horn silver). Crook County, Black Butte mines, Warrens Peak. Fremont County, associated with other ores in Wind River Mountain mines.

Cerium metals. See Allanite and Monazite.

Cerusite (carbonate of lead). Albany County, in schists and diorite at Esterbrook; has been mined and shipped. Carbon County, with galena and quartz at Ferris. Crook County, Black Butte mines, hard and soft carbonates; argentiferous; has been mined.

Chalcocite (copper glance). Albany County, in gneiss and schist at Jelm; gold and silver values; Doane-Rambler and other mines. Carbon County, important ore of Encampment district. Platte and Goshen Counties, important ore in Hartville Uplift; carries gold and silver at some mines.

Chalcopyrite (copper pyrites). Albany County, in granite and schist at Jelm mines; gold values. Carbon County, important ore of Encampment district; Seminole Mountains. Fremont County, South Pass City, with other ores. Laramie County, with iron ores in quartz at Ulcahoma mine, near Hecla; carries gold and silver. Park County, at Kirwin. Platte and Goshen Counties, important ore of Hartville Uplift.

Chromite (chromic iron ore). Large deposits in the southern part of the State. Converse County, mined at Deer Creek canyon, 15 miles southwest of Glenrock. Natrona County, similar deposit occurs on Casper Mountain.

Chromium. See Chromite.

Chrysocolla (copper silicate). Platte and Goshen Counties, Hartville iron range. Mined at Green Hope, Silver Cliff, and Copper Belt mines.

Chrysotile. See Asbestos.

Clay (brick). Abundant throughout the State. Brick made in the following localities: Albany County, Laramie. Big Horn County, Basin, Cody, Park, and Worland. Carbon County, Encampment. Converse County, Douglas. Campbell County, Gillette. Fremont County, Lander and Thermopolis. Natrona County, Casper. Platte County, Wheatland. Sheridan County, Sheridan. Sweetwater County, Green River. Also in other counties.

Clay (medicinal or paper). See Bentonite.

Coal. Estimated tonnage of coal in the ground second largest in the United States; about 50 per cent of the area of the State is underlain by coal-bearing formations.

Coal (bituminous). Laramie Basin.—Albany County, mined for local use at Rock, Dutton, and Mill Creeks.

Coal (bituminous and subbituminous). Green River field.—Carbon, Fremont, Sweetwater, and Uinta Counties; contains 4,800 square miles of available coal and 20,000 square miles of coal deeply buried. Carbon County, bituminous coal mined at Hanna and Rawlins. Sweetwater County, Rock Springs. Uinta County, Cumberland, Diamondville, Kemmerer, and Spring Valley.

Henry's Fork field.—Uinta County, coal widely distributed; little developed.

Coal (bituminous coking). Cambria field.—Weston County, large mine at Cambria; about 12 square miles of workable coal; has been coked.

Coal (subbituminous). Bighorn Basin.—Big Horn and Park Counties, mines near Basin, Cody, Crosby, Gebo, Meeteetse, and Thermopolis.

Powder River field.—Largest in the State; lies between Black Hills and Bighorn Mountains; extends from Montana line south to North Platte River; Upper Cretaceous and Eocene; beds have a maximum thickness of 45 feet; 11,000 square miles underlain by workable beds. Mined in Converse County at Glenrock, Big Muddy, Inez station, and Lost Spring; Johnson County, Buffalo; Sheridan County, Carney, Dietz, Monarch, and Sheridan. Small quantity for local use taken at many places.

Wind River Basin.—Fremont and Natrona Counties. Mined in Popo Agie Valley, 8 miles northeast of Lander and near Hudson; 8 feet.

Cobalt. Albany County, with gold-copper ores in Medicine Bow mines at Holmes. Laramie County, with copper ores in Silver Crown district.

Copper (native). Albany County, in granite at Rambler mine, Grand Encampment district. Fremont County, Copper Mountain district. Platte and Goshen Counties, Hartville Uplift; mined in Iron Belt mines.

Copper minerals. Copper is the predominant metal produced in the following districts: Albany County, Douglas Creek, Horse Creek, Jelm Mountains, and Laramie Peak. Carbon County, Encampment, French Creek, Rankin and Seminole. Converse County, Warbonnet. Fremont County, Copper Mountain, De Pass and Owl Creek. Goshen County, Rawhide Buttes. Johnson County, Bull Camp. Laramie County, Hecla. Natrona County, Casper Mountain. Park County, Kirwin, Sunlight. Uinta County, Cockscomb. See also Azurite, Bornite, Chalcocite, Chalcopyrite, Chrysocolla, Covellite, Cuprite, Malachite, Melaconite, Tennantite, and Tenorite.

Corundum (emery). Fremont County, Wind River Range; not mined.

Covellite. Albany County, mined at Rambler mine at Holmes, Grand Encampment district. Platte and Goshen Counties, Hartville Uplift.

Cuprite (red copper oxide). Albany County, Rambler mine at Holmes, Grand Encampment district. Big Horn County, prospects in Bull Creek, Walker Prairie, in Bighorn Mountains. Crook County, associated with hard carbonate ores at Black Buttes and Inyankara Peak; has been mined. Platte and Goshen Counties, mined in Hartville Uplift; prospects in Whalen Canyon, Muskrat Canyon, and Rawhide Buttes.

Epsomite (Epsom salt, magnesium sulphate) . Long, needle-shaped crystals in soda lakes in Albany, Carbon, and Natrona Counties. Brooklyn Lake, area 90 acres, covered with nearly pure deposit, near Wilcox station, Albany County.

Flagstone. Common in some localities as marble, limestone, and sandstones. Has been quarried for local use.

Galena (argentiferous). Albany County, mined for gold and silver in gneiss and schist at Jelm. Carbon County, at Ferris in fissure veins with quartz, cerusite, anglesite. Crook County, has been mined in Black Buttes. Park County, Kirwin.

Gas. See Natural gas.

Gold (lode). Produced in following districts, in most cases as predominant metal: Albany County, Centennial, Holmes, and Jelm Mountains. Crook County, Bear Lodge and Black Buttes. Fremont County, Atlantic, Owl Creek, and South Pass. Goshen County, Rawhide Buttes. Laramie County, Hecla. Lincoln County, Horse Creek, 85 miles north of Kemmerer, near Merna. See also Sylvanite.

Gold (placer). Albany County, Douglas Creek and Keystone. Big Horn County, Shoshone River and Bald Mountain. Carbon County, on the South French Creek. Crook County, Sand Creek and Nigger Hill. Fremont County, Atlantic and Lewiston; South Pass City, hydraulicking. In 1912-13 was dredged on Wind River, 7 miles west of Riverton and 8 miles northeast of Riverton, near Noble. Johnson County, in Kelly Creek near Buffalo, and in Bighorn Mountains. Park County, Shoshone River and Clark Fork at Crandall. Sweetwater County, Green River. Uinta County, in sands of Snake River, mined intermittently, and on Snake Creek.

Granite. Abundant in Bighorn Mountains, Hartville Uplift, Laramie Range, and Medicine Bow Range; production small.

Graphite (plumbago). Fremont County, near Miners Delight. Goshen County, Haystack Hills. Platte County, near Ironton; has been mined.

Grindstone. Carbon County, quarried near Rawlins; small production.

Gypsum. Albany County, rock gypsum is mined at Red Butte, and used by one mill for making plaster; gypsite, or earthy gypsum, is dug near Laramie and used by two mills for making plaster. Has been mined west of Sheridan; occurs abundantly in Big Horn, Carbon, Converse, Crook, Fremont, Johnson, Laramie, Natrona, Sweetwater, Uinta, and Weston Counties.

Halite (common salt). In soda lakes in Albany, Carbon, and Natrona Counties. Salt springs numerous in several counties. Crook County, at Cambria, salt was made by evaporating water of Salt Creek.

Hematite (red iron ore). Carbon County, extensive deposit north of Rawlins was mined for flux; also on south side of the Seminole Mountain, 35 miles north of Rawlins, and at Jelm mines. Platte and Goshen Counties chief ore of Hartville iron range; mined at Sunrise, Lone Jack, and Good Fortune mines.

Ilmenite (titanic iron ore). Laramie County, Iron Mountain; immense dike, not mined.

Iron. Iron is the chief metal produced in Laramie County, at Iron Mountain, and in Platte County at Hartville. Chromic iron ore is produced in Converse County, in Deer Creek district. See also Brown iron ore, Chromite, Mematite, Ilmenite, Magnetite, Mineral paint, Pyrite, and Pyrrhotite.

Kaolin. Carbon County, occurs near the soda lake, pure and in quantity.

Lead. See Anglesite, Cerusite, and Galena.

Limestone. Albany County, 3 miles northeast of Laramie, used for lime in beet-sugar refining. Limestone of Carboniferous and Jurassic age in many counties afford an abundance of good lime suitable for plaster; some of these limestones are hydraulic.

Limestone (building). Quarried: Albany County, at Laramie. Carbon County, Rawlins. Fremont County, Thermopolis. Laramie County, Horse Creek. Platte County, Hartville and near Guernsey. Sheridan County, Sheridan. Sweetwater County, Green River.

Limestone (flux). Quarried: Carbon County, at Rawlins. Platte County, Guernsey.

Limonite (brown hematite). See Brown iron ore.

Magnetite (magnetic iron ore). Albany County, in diorite near Foxpark. Carbon County, with hematite, near Rawlins.

Malachite (green carbonate of copper). Albany County, abundant in Rambler mine, and found in Blanche mine at Holmes, Grand Encampment district. Carbon and Crook Counties, prospects at Bull Camp and Walker Prairie, in Bighorn Mountains, with other ores. Park County, Kirwin, as vein mineral. Platte and Goshen Counties, important ore of Hartville Uplift; mined at Green Hope, Silver Cliff, and Copper Belt mines.

Manganese Ore. Albany County, west side of Laramie Peak.

Marble. Albany County, west flank Laramie Range; east flank Medicine Bow Range; 100-foot ledge of good quality, Cooper Lake station. Converse County, Douglas, red, good quality. Crook County, west flank Black Hills. Fremont County, Rattlesnake Mountains. Johnson County, Bighorn Mountains. Platte County, Hartville, east flank Laramie Range, abundant in the Carboniferous; pure white marble occurs 20 miles west of Wheatland.

Marl. Albany County, 15 feet pure marl, 8 miles southwest of Laramie.

Melaconite (black oxide of copper). Albany County, quantity in Rambler mine, Holmes. Platte County Michigan cine.

Mica (muscovite). Albany County, in Medicine Bow Range. Converse County, occurs in sizable plates at Glenrock. Fremont County, 60 miles west of Lander. Goshen County, in Haystack Mountains near Hartville. Platte County, near Ironton.

Mineral paint. Carbon County, made from soft iron ore at Rawlins. Suitable material at Hartville and other iron localities.

Mirabilite (sodium sulphate, glauber salt). In soda lakes in Albany, Carbon and Natrona Counties; has been mined in Albany County near Laramie and in Natrona County, Sweetwater Valley.

Molybdenite. Park County, in Bryan mine, at Kirwin.

Monazite. Carbon County, in black sands in Bald Mountain district. Sheridan County, reported from Bighorn Mountains.

Natron (carbonate of soda). Sweetwater County, Green River; borings in the Wasatch sandstone (Eocene?) at depths of 125 and 700 feet yield an almost concentrated solution of sodium carbonate utilized for the manufacture of caustic soda. Common in soda lakes of Albany, Carbon, Natrona, and Sweetwater Counties; not marketed.

Natural gas. Big Horn County, Bighorn Basin gas field; gas from anticlines at western base of Bighorn Mountains; used commercially at Basin, Byron and Greybull. Converse County, small field near Douglas. Hot Springs County, considerable quantities as yet not utilized, in Grass Creek oil field. Occurs in central Park County, near Cody, and in southern Park County, in Buffalo Basin.

Nickel ore. Converse County, in pyrrhotite, Esterbrook district. Laramie County, in ores of Ulcahoma mine, and associated with copper ores, Little London mine, near Hecla.

Niter. Sweetwater County, soda niter in Leucite Hills.

Oil. See Petroleum.

Oil shale. See Shale.

Ozokerite (mineral wax). Fremont County, occurs 20 miles southeast of Lander. Sweetwater and Uinta Counties, near Colorado line, in Tertiary and Cretaceous; shipped east for use in manufacture of ointments and insulating material.

Palladium. Albany County, in copper ores with platinum in Rambler mine at Holmes.

Petrified wood. Common in badlands in many parts of the State.

Petroleum. Productive areas of considerable importance in Big Horn County, near Basin, Byron and Greybull. About 15 wells drilled on Torchlight dome, 3 miles east of Basin; 10 wells on small anticline directly north of this dome; and about 35 wells on the Greybull dome, at the mouth of Greybull River. Petroleum, paraffin base, in Fremont County, north and east of Lander, near Riverton, Saddlerock; in Hot Springs County, along Grass Creek, 5 miles northwest of Ilo; and in Natrona County, at Salt Creek, north of Casper. Hot Springs County, in Grass Creek anticline, 20 or more wells drilled; nearly all found oil. Petroleum occurs in small quantities in Big Horn county, near Bonanza; in Converse County, near Douglas; in Crook County, near Moorcroft; in Johnson County, along Powder River; in Lincoln County, near Labarge; in Weston County, near Newcastle; and in Uinta County, near Spring Valley. The total production of the State in 1913 was 2,406,522 barrels, valued at $1,187,232; in 1914 it was 3,560,375 barrels, valued at $1,679,192.

Phosphate rock. Fremont County, extends 50 miles northwest and southeast from Lander and occurs along northern boundary. Hot Springs County, underlies area near Thermopolis and along southern boundary. Lincoln County, mined and shipped at Cokeville; large area 140 miles long; beds 10 feet thick.

Platinum. Albany County, in copper ores of the Rambler mine at Holmes. Lincoln County, in concentrates from Snake River placers. See also Sperrylite.

Potash. Sweetwater County, large quantity in wyomingite and other rocks of Leucite Hills. No method known for making it commercially available. See also Niter.

Pumice. Albany County, beds 4 to 6 feet thick near Sportsmans Lake.

Pyrite (iron pyrites). Albany County, with copper ores Encampment district in Jelm and Ulcahoma mines; mined for gold and silver content. Sweetwater and other counties, with gold and quartz veins; little worked.

Pyrrhotite. Albany and Converse Counties, underlying iron oxides at Cooney Hill and with copper ores in prospects in North Laramie district.

Road metal. See Asphalt, Granite, Limestone, Marble and Sandstone.

Salt. Uinta County, mined at Auburn. Salt produced from brine south of Star Valley on Salt Creek. See also Halite.

Sand (building). Dug in small quantity for local use at many places.

Sand (glass). Albany County, from soft sandstone of Casper formation. Has been quarried 3 miles east of Laramie.

Sandstone. Albany County, quarried at Laramie, small quantity. Big Horn County, Cody. Carbon County, Rawlins. Crook County, Aladdin. Fremont County, Lander and Thermopolis. Laramie County, Iron Mountain and Underwood. Sheridan County, Arno, Dietz, and Absaraka Park. Uinta County, Cumberland, Evanston, Oakley, Frontier, and Glencoe, and at many other towns and villages.

Shale. Albany County, used for making brick at Laramie.

Shale (oil). Green River formation (Eocene), in southwestern part of the State, on Green River and its tributaries; some shale rich in oil.

Silver (native). Platte County, Silver Cliff mine in Hartville Uplift and in other copper mines. See also Argentite, Cerargyrite, and Sylvanite.

Sperrylite. Albany County, has been found at Rambler mine, Holmes.

Sphalerite. Platte County, mined with hematic in Hartville mines.

Sulphur. Hot Springs County, massive and in small crystals in travertine near Thermopolis; mined and shipped. Park County, in local deposits on south side of Shoshone River; at lower end of Shoshone Canyon, and on west side of Sulphur Creek; occurs in the Sunlight Basin, 52 miles northwest of Cody; has been mined near Cody.

Sylvanite. Crook County, occurs in Bear Lodge Mountains.

Tennantite. Platte County, has been mined north of Guernsey in Copper Bottom prospect, SE¼ sec. 23, T. 29 N., R. 65 W.

Tenorite. Albany County, quantity at Rambler mine, Holmes.

Thorium. See Monazite.

Tin. See Cassiterite.

Titanium. See Ilmenite.

Travertine. Hot Springs County, near Thermopolis, on Bighorn River (abundant), and in Yellowstone National Park in the northwestern part of the State.

Trona (sodium carbonate). Sweetwater County, number of wells at Greenwater; produce good soda; shipped.

Tufa. See Travertine.

Tungsten. See Wolframite.

Wolframite. Albany County, small stringer in copper mine near Holmes.

Wood, silicified. Abundant in Yellowstone National Park.

Wyomingite. Sweetwater County, in Leucite Hills, abundant. Future source of potash when method for making it commercially available is discovered.

Yttrium. See Allanite.

Zinc. See Sphalerite.

Advertising Sometimes Pays

Eighteen years ago the Burlington railroad included in their advertising folders an account of a gas well that had then been burning in a prodigal manner for a period of several years in the Big Horn Basin. By chance one of these folders fell in the hands of some West Virginia gentlemen who immediately journeyed to the Basin, secured acreage in the vicinity, and drilled several wells. Shortly afterwards their company piped gas to Greybull and Basin. Their efforts marked the beginning of the big gas industry as known in Wyoming today.

Since the auspicious occasion referred to, not the Burlington, but the State of Wyoming, has acquired joint proprietorship to most of the gas structures located within her boundaries. As everyone knows, these natural reservoirs are now operated under terms that pour big royalty payments directly into the treasuries of the state and national government.

From an economic standpoint, an entirely different set of problems face the State today than existed 18 years ago. To begin with, instead of producing not enough gas, a report has recently been current that production already brought in and held in storage exceeds developed market demands by the quite conservative safety-factor of 1,100 per cent. This estimate may be high, but then on the other hand, many tax-payers know the locations of at least some of the big gas structures brought in by our oil and gas pioneers at heavy expense several years ago and from which no pipelines have yet been laid.

Ordinarily, when a proprietor produces far more goods than his present customers can consume, an aggressive advertising campaign is staged to secure new customers. When the advertised product happens to be of unsurpassable merit, a new and lasting market is frequently founded by the drive. As developments now stand, it may pay for some private or public agency to circluate more advertising folders on the gas resources of this State.

Outside of Wyoming, reserves of the most ideal form of natural fuel do not commonly glut the market for undue

periods of time. On the contrary, some sections that were industrialized in an intensified manner, following local gas discoveries, now find serious shortages of their most preferred fuel to be existing within their immediate environments. In those unfortunate areas some individuals may be interested in learning about the huge gas structures that have long remained undeveloped within Wyoming.

In prospective advertising areas, no agency is now engaged in broadcasting the rock-bottom rates that 26 towns and cities in Wyoming already offer industrial concerns desirous of consuming large quantities of real high power gaseous fuels. Moreover, these Wyoming municipalities are in a position to guarantee existing rate structures for far longer periods than obtainable elsewhere. Other advantages could be cited for Wyoming. For instance, her resort climate, industrially speaking, is superior to the sub-tropical temperatures that prevail in regions that now yield the most gas in America.

Of all minerals produced under the direct proprietorship of Wyoming, gas should lead the vanguard in the attraction of industries to our State. At present all profits yielded by the infant industry are expended on divers forms of civic betterments that have little or nothing to do with the future potentialities of the business itself. In course of time profits plowed back into the business should accelerate industrial expansion by several fold. Evidently, such development would greatly augment the royalty payments at present received from the gas industry.

To what competitive degree the priceless irrigation waters of Wyoming have enriched the agricultural prosperity of neighboring states is already a matter of history. To what cost her own matchless fuels will also serve to promote their future industrial expansion may soon become a problem for the prophets to prognosticate about.

For all reasons mentioned, the day should soon be here when Wyoming, herself, can afford to tell the world of her own, individual and undivided, supremacy within the select field of high power gaseous fuels.

Part II

General Economic Papers

PART II

General Economic Papers

CHAPTER I

MINERAL INDUSTRY EXPANSION AND CIVIC BETTERMENTS

In 1915, the mineral production of Wyoming was $12,708,235. In 1925, the last year that a census of State was taken, mineral production reached the imposing total of $78,754,915. This unparalleled increase equaled 520%. Comparatively, the expansion was over 11 times greater than the 45.6% increase in population that occurred within the decade.

In this decade Wyoming advanced from an unimportant to a leading position among the mineral producing states. For past several years annual mineral production has averaged $400.00 for each person in the State. This figure is only $30.00 short of the total per capita income of the United States as recorded by latest calculations. In no other state is so large a per capita income derived from native mineral resources, alone.

In 1915, Wyoming was a part of the wide open spaces that still find frequent reference in current literature. Between the most important cities the primeval roads and trails were often impassable, and in more isolated sections, school activities had to be suspended for weeks at a time during severe winter months. Today, all cities and hamlets of Wyoming are interconnected by a modern highway system, and for the education of the youthful residents, a school system unexcelled by any state is completed.

Without huge develpoment of new mineral wealth it would have been impossible to finance either one of these extremely costly systems within so brief an interval. For the completion of these modern improvements the rapidly expanding mineral industry not only paid huge production taxes, but in addition thereto, public treasuries were enriched more than $50,000,000 by royalty and bonus payments tendered by the oil industry within past 8 year period.

As a provider of public revenue the taxable returns of the mineral industry gained more than 1,000% within a decade in which the population of the rapidly growing State increased slightly less than 50%. In fact, tax and royalty payments of 1925 exceeded the total value of all mineral produced in Wyoming during the preceding State census year of 1915.

CHAPTER II

THE RECORD MINERAL ROYALTY PAYMENTS RECEIVED BY WYOMING CAN BE INCREASED

Direct State Royalties—Joint Federal and State Royalties—Wyoming Pays the Far Larger Portion of All Federal Royalties Collected by Federal Treasury—Federal Treasury Receipts Under the Mineral Leasing Act of February 25, 1920, From Date of Act to Nov. 1, 1928—Wyoming Royalties Diverted Entirely to Non-Mineral Pursuits—Actual Operation of Present Irrigation Act Could Vastly Aid Mineral Development in Wyoming—More Cultivation.

Direct State Royalties

Unlike all other states, most of the mineral production of Wyoming is from lands either owned by the State or by the Government. About 6% of the area of the state are the school sections Nos. 16 and 36. Many of these sections have passed into private ownership, but in nearly every instance the state has retained the mineral rights thereto. Owning the lands, or at least the mineral rights of these several thousand school sections, a due share of Wyoming's mineral production is now being conducted by the state, itself. Among these lands is the famous Section 36 of the Salt Creek field, the oil content of which has been frequently appraised at no less than $100,000,000. At the present time this record producer yields the princely royalty of 65% directly to the Treasury of the State. Manifestly, in years to come, the royalties from this unsurpassably rich school section should greatly exceed the $9,200,000 figure already collected therefrom.

Joint Federal and State Royalties

Approximately 70% of the remaining area of the state is either Public Domain or else private lands in which the

Government reserved the mineral rights when title was transferred to the homesteaders and other original claimants. To operate on these lands the Act of February 25, 1920 specifies that leases be awarded to the highest bidders at public auctions. From the funds so received the law further stipulates that 37½% of their total be returned directly to the state from which they originated, and that all but 10% of the remainder be expended on the construction of additional irrigation projects in the western arid states. As the law stands, Wyoming, in reality, is also a joint owner and proprietor of the various forms of mineral production that are now being carried on the vast Public Domain situated within her borders.

Wyoming Pays the Far Larger Portion of All Federal Royalties Collected by Federal Treasury

The amount of revenue annually received from these public operations is tremendous. The receipts of Wyoming are unapproached by any other state, or even by all remaining states of the Union. In the following tabulation, based on figures recently received from the Commissioner of the General Land Office, the Wyoming royalty payments are compared to the payments made by all other states for each year since the passage of the Federal Leasing Act.

Federal Treasury Receipts Under the Mineral Leasing Act of February 25, 1920, From Date of Act to Nov. 1, 1928

Year	Paid by Wyoming	Paid By All Remaining States
1921	$3,172,867.45	$6,553,109.86
1922	4,173,998.94	4,625,469.23
1923	6,466,694.10	1,113,341.47
1924	12,270,500.75	1,361,339.97
1925	6,953,501.44	1,325,207.18
1926	6,883,125.55	1,501,593.21
1927	5,097,775.42	1,571,743.34
*1928	3,730,347.95	2,021,359.48
TOTALS	$48,748,811.60	$20,073,163.74

*Includes to Nov. 1, 1928, which is 4 months after fiscal year ending June 30, 1928.

As disclosed by the preceding tabulation, Wyoming has so far paid 71% of all the mineral royalties collected by the Federal Treasury. The balance of 29% represents the sum total payments received from all remaining 47 states of the Union ever since the Federal Leasing Law was enacted. If public royalties should be used as an index for mineral production, the Wyoming factor would cause the totals of not one, but all other states to disappear almost completely from the field of view. Manifestly, it pays to produce minerals on the Public Domain of Wyoming. So long as her royalty payments remain 243% as great as the sum total returned by the balance of the nation, no conceivable business venture could possibly offer a greater degree of income to the public treasuries than the continued exploitation of the rich oil and mineral lands of Wyoming.

Wyoming Royalties Diverted Entirely to Non-Mineral Pursuits

Strange to relate, few taxpayers have deemed it advisable to return any portion of the many million of dollars yielded by our foremost industry in the form of direct revenue back into that matchlessly profitable enterprise itself. So far, certain Departments of the State Government have been of the opinion that every dollar of the huge funds extracted from the industry must be expended along lines of endeavor that are totally non-mineral in character.

In regard to disposition of the mineral royalties paid by Wyoming, the views of the Federal Government are almost identical to those held by the State. Instead of returning any portion of these receipts to the mineral industry, they are largely used to subsidize betterments for the giant agricultural industry of the nation. As the law now reads, fully 52½% of these colossal receipts are to be expended on the construction of irrigation projects throughout the arid west. Ordinarily, such expenditures can be of little aid in the development of the mineral industry either in Wyoming or elsewhere.

Actual Operation of Present Irrigation Act Could Vastly Aid Mineral Development in Wyoming

Should the time come when it would be deemed expedient to expend Wyoming royalty payments on the construction of irrigation projects directly within Wyoming, several ways and means would be opened to promote further expansion in the mineral industry.

Construction of additional irrigation projects on our exceptionally high gradient river courses could not be effected without the development of huge hydro-electrical potentials. As soon as these immense supplies of energy would become available, it would be more feasible to manufacture abrasive materials, ferro-alloys, light-alloys, chemicals, explosives, pigments, super-double-fertilizer salts and other modern products of high intrinsic value directly from the vast mineral reserves that have long lain dormant in the valleys of our major river courses than at Niagara Falls and other huge water power sites where similar reduction operations have long been conducted as extremely profitable ventures.

As devised, almost every chapter of this book points out how dual irrigation and power development would expand the mineral industry of our State. Obviously, only one interpretation of the existing leasing act can be fair to Wyoming, the Sovereign State that has already paid 71% of the gross mineral royalties received by the Federal Treasury. Wherever possible, leasing law irrigation projects should be constructed that will yield, not only, indirect revenues from farm lands, but also direct royalties from local mineral and chemical deposits of the character alone reducible by the temperature generated in the electric furnace. In Wyoming, successful exploitation of huge reserves of these more refractory raw materials is chiefly dependent on the future development of the immense hydro-electrical resources still remaining intact in our major stream courses.

More Cultivation

This office has always been an advocate of more cultivation, agricultural and otherwise. In lieu of cultivating larger acreages in distant arid states its interests, however,

are mainly centered in the growth and expansion of a bigger and better mineral industry directly within Wyoming. For this procedure many ways are open in which a minor portion of the huge mineral royalties paid by Wyoming could be expended for the object of reaping bigger harvests of extremely vital mineral royalties.

The next big move in Wyoming mineral development should logically include the exploitation of her vast reserves of salines, chemicals, and more refractory ore deposits. Unlike other states, Wyoming has not only the requisite raw materials, but also a volume of hydro-electrical potential amply adequate to transform these lowly deposits into finished products of high intrinsic value. For the development of the latter form of energy, a just and equitable operation of the construed intents and purposes of the existing Federal Mineral Leasing Act should prove of greatest aid.

CHAPTER III

FUTURE PROGRAM FOR HYDRO-ELECTRICAL DEVELOPMENT

Available Potentials—Present Completions—Two Widely Known Proposals—A Federal Policy—Wyoming versus Niagara Falls—Statesmen Have Been Working—Power Demands of Rich North Platte Valley Are Insatiable—National Aspect of Green River Development—No Portion of Huge Mineral Royalties Paid by Wyoming Are Used to Strengthen the Mineral Industry.

Available Potentials

In response to inquiries recently addressed to United States Geological Survey, the following estimates and latest revisals were received in regard to the potential waterpower resources of Wyoming:

Energy available 50% of the time—1,182,000 Horse-power.
Energy available 90% of the time— 704,000 Horse-power.

According to the first rating, only nine states of the Union contain potential waterpower of greater magnitude than Wyoming. To those who continue to speak slightingly of modern hydro-electrical development, it may be surprising to learn that within the vast agricultural and industrial empire that lays directly to the east, only one state can exceed the Wyoming total in both developed and undeveloped waterpower. That state is New York and at the single site of Niagara Falls are the most powerful hydro-electrical completions so far constructed by the hand of man. As a large share of the New York and other eastern development is already completed, it is apparent that the comparatively near resources of Wyoming should soon attract due attention.

Present Completions

Until past few years, practically no steps had been taken to develop the huge volumes of latent energy contained in river courses that descend precipitously from off the lofty, perpetually snow-adorned mountain slopes of Wyoming in all cardinal directions of the compass. In 1927, two pioneer developments were, however, completed by the Federal Reclamation Service. At Guernsey, the impounded flow of the North Platte River now generates 6,800 horsepower of continuous energy, and near Cody, a small initial unit constructed at the foot of the towering Shoshone River dam develops 2,200 horse-power. At Guernsey, the marketing and distribution of the hydro-electrical power is under the control of one of the largest public utility corporations of the nation. At Cody, a strong local corporation has sold most of the power output for the development of the newly discovered Oregon Basin oil field. It is thereby interesting to note that the infant hydro-electrical industry of Wyoming has so far attracted capital of the soundest order.

Two Widely Known Proposals

In Wyoming, the topmost drainage areas of the larger river courses generally occupy ice-caps, glaciers, and similarly elevated terrain from which the run-off is highly seasonable in character. To obtain uniform and maximum development, the completion of equalization structures in the form of storage reservoirs is indeed compulsory within the rock-ribbed canyon sites of solid granite that long ago geologic agencies fortuitously excavated along the lower reaches of our major river channels. Structures of this type have been built on the larger irrigation projects already completed in the State. So far, none of the existing structures possess the power potentialities that would be available by the completion of either the Casper-Alcova Irrigation Project or the major development proposed for that sector of the Colorado River Basin that is situated in Wyoming. By the completion of the diversion dam at Alcova, 30,000 horse-power would be generated throughout the irrigation season; and by the construction of the power dam

proposed for the Wyoming tributary of the Colorado River, no less than 71,000 brake horse-power would be available the year around. Either one of those completions will multiply existing power development in Wyoming by many times.

A Federal Policy

River development in the United States has always been a problem of the Federal Government. Until lately, the irrigation industry has alone supplied all of the interest that the West has taken in river development. In bordering states of the prairie type of topography, that single interest or motivation is clearly explainable. For in erecting engineering structures along their sluggish stream channels, no new wealth, aside from irrigation values, was created by the costly expenditures of the Reclamation Service.

In Wyoming, utilization of water resources can no longer concern the attention of any single department of the Federal Government. Unsurpassable topographic and geologic conditions demand that the inseparable questions of land reclamation, power generation, and modern mineral exploitation each and all receive due consideration in the improvement programs of the future.

At present, Wyoming leads all states in reserves of one form of refractory iron ore, as well as in deposits of several important raw chemicals and solid fuels. For the conversion of the more refractory of these materials into metallic alloys, brilliant pigments, soluble fertilizers, and many other finished products of similar intrinsic value, the use of modern high temperature processes is imperative.

Wyoming versus Niagara Falls

At the largest hydro-electric completion in United States, raw ores and chemicals typical of local deposits are hauled from foreign ports for final reduction. Manufacturing enterprises of the future will probably deem the present practice to be decidedly uneconomical, and due to that reason a direct market of limitless extent will at all times await the utmost maximum capacity which the hydro-electric industry may develop in Wyoming. Today, the production of a commodity as modern as electrical energy is no-

where a drug on the market. In the future the exploitable mineral deposits of Wyoming will be found to be of sufficient magnitude to consume the last kilowatt of energy that can be generated from her exceptionally high gradient river channels.

Statesmen Have Been Working

During present year, river development legislation made more progress in Congress than ever before. Due to efforts of the leading statesmen of Wyoming, many residents now have reason to believe that the day for building huge engineering structures on the major river systems of the State has been advanced most materially.

At present, the two great river improvement projects of Wyoming are those of the North Platte and Green River basins. Towards the practical solution of these huge engineering problems, the present Executive of the State has concentrated most of his time during past eight year period. As yet, few taxpayers have formed a complete concept of the economic benefits that will accrue to the State as soon as the technical, legal and diplomatic ramifications that have long entangled those two great projects are finally unraveled. In addition to many thousand acres of reclamable lands, each one of those major river basins happens to contain an unrivaled mineral deposit, unique by itself, the exploitation of which will go a long way towards making America a stronger self-contained nation in the complete mineralogical sense of the word.

Power Demands of Rich North Platte Valley Are Insatiable

Locked up in the North Platte River valley at Iron Mountain is the largest deposit of high grade titaniferous iron ore known in America. From calculations appearing in the report that a widely recognized electro-metallurgist filed on the property, the 30,000 horse-power of the proposed Alcova diversion dam would provide sufficient electro-thermal energy to isolate 46,875 tons of ferro-titanium in each six month period of the year in which the comparatively near irrigation structure would operate at full capacity. In less than no time, such a production from the exhaustless reserves of Iron Mountain would completely

inundate the market for the metallic alloy now selling at $200.00 per ton. Moreover, the local electro-metallurgical reduction would doubtlessly interfere with operations of the strongest paint making corporation of United States which last year set up manufacturing plants in several European nations with the view of supplying domestic requirements of titanium oxide from abroad. In recent years the oxide of titanium was discovered to possess superior pigmentation properties. It is far more efficient than white lead in spreading power and being chemically inert, it is the most lasting paint so far manufactured. If the Iron Mountain deposit is exploited on a large scale, its enormous titanium content would go a long way in replacing white lead as a modern pigment material in America, the greatest of all national markets.

For starting paint or metallurgical works within Wyoming, no force will likely prove as potent as the future exploitation and utilization of the hydro-electric resources still remaining intact in the channel of the North Platte River.

National Aspect of Green River Development

Completion of the Green River proposals would effect even more profoundly the economic structure of the State as well as the nation at large. Perusals undertaken of the extensive literature so far accumulated on the hearings of Federal Colorado River Commission show that the surplus discharge of the most prolific feeder of this large interstate channel is sufficient to reclaim an additional million acres of land directly within the confines of Wyoming, alone. When all of this arid land is irrigated the cultivable acreage of America will be augmented to an extent considerably greater than the total area of one of the smaller eastern states. For adding, in reality, supplemental agricultural states to the existing forty-eight, no national program is as ambitious and constructive as that of the Colorado River Commission. In a single valley in Wyoming the absorptive power for expansion in this direction is indeed of no mean dimension.

To the agricultural industry, far more than the reclamation of additional lands in Wyoming is betokened by the

completion of the Green River proposals. In the Leucite Hills that form some of the more pronounced topographic features of the valley, Government geologists have estimated a total potash content of slightly less than 200,000,000 tons. Outside of the European fields, no potash reserves exceed the tonnage of the Leucite Hills. At present rate of importation, the Wyoming deposit would safely satisfy American demands for nearly 800 years.

Unlike European deposits, the potash of the Leucite Hills occurs in an insoluble form. To break down the refractory mineral in the soluble form that potash is assimilated by plant life, the use of a high temperature process is often required.

The complete breaking down of even the leanest and most refractory potash silicates has long been demonstrated in the laboratory of the analytical chemist as well as in the operations of a major industrial activity. Had the $200,000 appropriation bill of Representative Winter passed in last Congress, information of a conclusive character would be available to the American agricultural industry at a greatly advanced date in regard to the cost of potash production in the Green River valley on a national scale. So far, neither private nor Governmental agencies have attempted a solution of this important economic problem. Other technical advancements, cited in prior Potash Chapter, plainly disclose that for volatilization and electrical precipitation of rich potash content in the leucite rocks, a tremendous amount of heat must necessarily be consumed. For generating the highest temperatures at the lowest cost, a large supply of hydro-electrical energy is essential. Upon completion of developments, previously described, no less than 71,000 horse-power of continuous hydro-electrical energy will be generated on the Wyoming tributary of the Colorado River. This volume of electro-thermal energy will prove amply sufficient to reduce the annual tonnage of American potash requirements directly from the refractory rocks of the Leucite Hills.

No Portion of the Huge Mineral Royalties Paid by Wyoming Is Used to Strengthen the Mineral Industry of America

Green River development unmistakably offers far broader potentialities than the irrigation of vast acreages directly within Wyoming. Inseparably tied to the local project is a solution to the great problem of soil fertility in the United States. In lieu of reclaiming a single state, the problem, in reality involves the continued reclamation of all 48 states in the Union.

Not so long ago, almost the entire supply of a fertilizer vital for the growth of plant life was shut off from entrance to American shores for a period of over four years. Locked up in Wyoming is an exhaustless supply of this indispensable chemical. To prevent a recurrence of the extremely acute situation of ten years ago, it is appropriate that steps be taken to exploit the greatest known domestic deposit at the earliest practicable date.

To relieve the American agricultural industry from future perils and accidents of a foreign monopoly, no problem should command more attention from the various technological branches of the Government than that of exploitation of the exhaustless potash reserves of Wyoming. To date, the Wyoming record for the advancement of agricultural prosperity in outlying states has been of a supreme and matchless order. For the reclamation of arid lands situated in that half of the nation that extends from the Missouri River to the Pacific Coast and from the Canadian to the Mexican borders, Wyoming long ago deeded away huge volumes of priceless life-giving waters that descend in all directions from off her sector of the Continental Divide.

Moreover, for the expressed purpose of financing the cost of many irrigation projects constructed throughout the Great West, the mineral royalties paid directly into the Federal Treasury by the State of Wyoming have exceeded the stupendous figure of $49,000,000.00 within past eight year period. If a small fraction of this record breaking tribute, solely surrendered by the mineral industry of Wyo-

ming in lieu of the national agricultural industry, had been expended on the exploitation of our most promising mineral deposit, today, Wyoming would not only be still doing far more than her share in supplying water as well as capital needed for the reclamation of the arid West, but also, her exhaustless stores of vitalizing forces would go a long way in assuring the continued fertility of those depleted lands in which lay the Corn Belt of the East and the Cotton Belt of the South.

For early expansion within the Wyoming industrial and agricultural empire, no constructive program offers more protection and promise than the immediate and complete development of our leading river courses. For reasons briefly touched upon herein, no state can offer greater potentialities for development of water resources than Wyoming. In course of time, the able efforts put forth by our leading statesmen on this important problem are bound to bear fruit. In the meanwhile, their labors are entitled to the continued appreciation and support of the citizens of Wyoming. Finally, all can remain assured that no state will ever be able to challenge successfully the sum total supply of energy amassed within the Wyoming depository in which is contained huge reserves of every known type of fuel, vast undeveloped hydro-electrical potentialities, as well as an unprecedented store of those vital forces of a mineral origin that are commonly consumed by the whole range of plant and animal life in the attainment of its structural growth.

CHAPTER IV

WYOMING IS READY FOR RAILWAY ELECTRIFICATION

The Big Year in Railway Electrification—Present Transcontinental Development—A Big Coal Road Adopts Electrification—Wyoming Has a Hydro-Electric Site and Many Steam Power Sites—Other Favorable Enonomic Factors—Some Unsound Proposals.

The Big Year in Railway Electrification

During the year railway electrification in the United States received a new impetus. Last month both the Reading and the Pennsylvania announced electrification programs involving expenditures of $20,000,000 and $100,000,000, respectively. Moreover, it is known that the New York Central has made extensive study of the possibility of completely electrifying its four track lines over the 440 mile section that lays between New York and Buffalo. Announcement of such a major program has been awaited during the several months past.

Present Transcontinental Development

At present, the St. Paul is well in the van of electric operation among the transcontinental systems. Lately, its original electrified unit was extended to a total distance of 677 miles. The extended completions cover virtually all of the mountainous grades where loads are heavy and power can be obtained locally by hydro-electrical development.

Wyoming Has a Hydro-Electrical Site

Recently, this office was favored with a private report prepared by the technical staff of one of the largest dual engineer-investment firms of America. Therein, the hydro-electrical site at Seminole Mountain on the North Platte

River was found to possess a potential sufficient to supply markets of the type already developed on the Missouri River at Great Falls, Montana. Most of the current consumed over the steepest and longest section of the St. Paul electrification is generated at the Great Falls site. In Wyoming a hydro-electric installation of 66,000 continuous horsepower could be set-up in the Rawlins region, distant less than 30 miles from the largest of all transcontinental railway systems.

Steam Power Electrification Is Best for Mountain Grades of Large Coal Carrier

For past several years the engineers of Wyoming have been greatly interested in the electrification development of the Virginian Railway, one of the largest of the coal transport systems of the East. The program for this comparatively new road was authorized in 1923 and since then electrified sections have been annually extended. The Virginian, essentially a coal road, has found electric operation advantageous and decidedly economical for hauling its heavy loads over the mountains.

Students of railway economics in this State have been undeniably impressed in regard to the vast progress that electrification has made in the United States, particularly during closing months of 1928. Electric traction at maximum requirements is about 250% as efficient as steam traction, but owing to the colossal investments required for transformation, only the strongest roads can afford to finance extended units of the latest advancements in modern transportation service.

Coal in Abundance for Steam Electrification

Present trends of development are decidedly favorable for electrification of divisions similar to the entire Wyoming sector of the Union Pacific railroad.

Over these major power consuming divisions of the highly progressive system, low cost electrification is possible by either waterpower or steampower development. In addition to the Seminole site, huge seams of coal are successively crossed by the favored route from Albany County

clear through to the Utah line. Development of the latter resources at several sites would largely eliminate the costly transmission losses suffered by those systems that are forced to conduct current long distances from the powerhouses.

Other Economic Factors

For future expansion in the electrification field, Wyoming could produce either hydro-electric or steam power at less expense than the cost of recent completions elsewhere. The developments of the year have greatly stimulated interest in hydro-electrical sites similar to that of the Seminole Mountain. Should a strong utility corporation develop this site, the railway market would first be sought as an outlet for the current.

As soon as either type of electrification would be provided, far longer and faster trains will operate over the more mountainous grades of Wyoming. Already, the Union Pacific operates its trains on a roadbed ballasted with the dustless carpet quarried from the Sherman Hill pits of pure granite rock. When smoke is also eliminated by electrical operation, a service beyond compare will be provided for the passenger of the increasingly popular Overland Route.

Recondite Proposals of No Interest to Wyoming

Recently discussions have arisen for costly waterway development to be financed largely by governmental funds over magnificent distances that traverse the interior section of the United States. By listening to such remarks one would believe that the railroads are no longer able to take care of their increasing traffic volumes. As yet, the proposals advanced mean nothing for the logical development of Wyoming. Should transcontinental traffic increase twofold or even more, Wyoming's greatest taxpayer would not hesitate long to develop either the black or white coal potential requisite to handle this augmented business over the double track system that she has completed throughout the entire length of the State.

For future traffic expansion of the transcontinental type, no distant canal or other mystic project would prove

as economical as actual development of the exhaustless, low-cost, power producers that an all providing providence long ago deposited directly within the strategic expanse that now forms the entire State of Wyoming. Apparently, these resources were intended for more than the development of Wyoming, alone. As yet, they remain of ample magnitude to take care of the development of additional states visibly barren of the varied forms of basic power-producers.

CHAPTER V

WYOMING LEADS THE PROCESSION OF STATES

Among the states, Wyoming is 47th in population. On the other hand, in residents that include the most magnificent species of wild faunal life habitant to the American continent, Wyoming still eclipses all states in either number or variety.

In the mineral industry the standings of Wyoming are far more impressive. The leading ranks that Wyoming commands in this industry among the states are partly included on the tabulation appearing on following page:

RANKING CHART OF WYOMING AMONG THE STATES

Rank	Item	Amount or Authority
FIRST	**Mineral Reserves**	
	Coal	1,076,620,100,000 tons
	†Gypsum	(See footnote)
	Titaniferous Iron Ore	U. S. Bureau of Mines Estimate.
	Tschermigite (Ammonia Alum)	2,500,000 tons
	Leucite (10% Potash Content)	1,973,000,000 tons
	†Bentonite	(See footnote)
	Economical and Industrial	
	Mineral Production per capita	405.11
	Mineral Royalties Paid to U. S. Treasury	***$48,748,811.60
	Undeveloed Mineral Wealth	$151,600,000,000.00
	*Bentonite Production	(See footnote)
	Percentage of Coal Mined by Machinery	29.8%
SECOND	Altitude (Stature)	6,700 ft. (Average for State)
	Per Capita Wealth	$4.961.00
THIRD	Radium Production (to date)	$33,857.48
	**Carbon Black Production	6,294.000 lbs.
FOURTH	Sodium Salts Production	U. S. G. S. Report
	Phosphate Production	U. S. G. S. Report
FIFTH	Chrome Iron Ore Reserves	U. S. G. S. Report
	Phosphate Reserves	115,754,000 tons
	Oil Shale Reserves	††1.826.400.000 bbls.
SIXTH	Oil Production	21,900,000 bbls.
	By-Product Gasoline from Natural Gas	43,100,000 Gal.
SEVENTH	Gas Production	45,539,000,000 cu. ft.
	Iron Ore Production	630,387 tons
EIGHTH	Area	97,914 sq. mi.
TENTH	Coal Production	6,738,561.57 tons
	*Gypsum Production	(See footnote)
	Hydro-electrical Potential	1,182,000 H. P.
TWELFTH	Copper Production (to date)	31,672,137 lbs.

*Cannot publish statistics without disclosing operations of private concerns.

**Unless otherwise stated, all production statistics are for last available year.

***To Nov. 1, 1928.

†Largest and most widely distributed deposits known. Tonnage calculations not completed.

††Est. of U. S. Oil Conservation Board.

Manifestly, the foregoing tabulation is far from a complete work. To calculate the colossal coal content of Wyoming required more than 25 years of hard labor on the part of the United States Geological Survey. Other estimates heretofore filed on the gold, iron ore, petroleum and other important reserves typical of Wyoming were found on examination to be of too subtile character to receive any mention whatsoever in foregoing table of comparative ratings.

Good reasons exist for the belief that Wyoming leads all states in deposits of asbestos as well as divers sorts of sodium and magnesium chemical salts. Originally, it was intended to include these and some other minerals under the No. 1 listing of preceding tabulation. Finding all investigational work to be of a fragmentary order, sufficient authorities could not be cited to warrant the listing of these valuable minerals under any number of preceding tabulation.

As years pass and as more definite information is collected, more and more listings can be added to the purely preliminary tabulation, hereinbefore recorded. Moreover, as Wyoming and adjoining states grow, a broader market will be created for the leading mineral products of Wyoming. Such development will decidedly advance the extremely high production ratings already achieved by Wyoming.

A vast amount of work remains to be done before either the inherent or unfolded values of Wyoming can be expressed by any comparative set of statistical ratings. At present, manifold factors are operating that will assure the preparation of more extensive and conclusive rating charts in the near future.

CHAPTER VI

THE SUPREMACY OF WYOMING IN THE 20 LEADING MINERAL PRODUCTS OF THE NATION

Tabulation—Four Industrial Classifications—Mineral Fuels—Steel Making Materials—Building and Structural Materials—Non-Ferrous Ores—A Self-Contained State—The Pennsylvania of the West.

Before a picture of the mineral wealth of Wyoming can be drawn, one should know what are the great mineral products of the nation. In the tabulation appearing below, their names are ranked in respective order of production values for the year of 1926 as recorded by the U. S. Bureau of Mines:

THE 20 LEADING MINERAL PRODUCTS OF THE UNITED STATES

Rank	Name	Production for 1926
1	Coal	$1,657,576,000
2	Petroleum	1,447,760,000
3	Pig Iron	749,633,468
4	Clay Products	430,428,494
5	Coke	307,773,402
6	Natural Gas	299,238,000
7	Cement	280,785,583
8	Copper	243,547,000
9	Stone	188,308,590
10	Iron Ore	174,015,645
11	Natural Gas Gasoline	136,412,000
12	Sand and Gravel	111,338,701
13	Lead	108,910,000
14	Zinc	91,799,000
15	Ferro-alloys	61,368,407
16	Gold	48,269,600
17	Gypsum	46,721,219
18	Lime	41,566,452
19	Silver	39,136,497
20	Aluminum	37,583,000
	Total	$6,502,171,058*

Production of the 20 minerals, above listed, represents 90% of the business provided annually by the giant mineral industry of America.

Four Industrial Classifications

To describe the supremacy of Wyoming in the foregoing products would require an entire rewriting of present volume. As a matter of fact, all of these 20 mineral products fall within the four giant industrial groupings, listed and classified below in their respective order of economic importance:

I—Mineral Fuels.
II—Steel Making Materials.
III—Building and Structural Materials.
IV—Non-Ferrous Metals.

To avoid reiteration of prior descriptions, from hence on this chapter will merely point out the superlative supremacies that Wyoming offers within the four major industrial fields, afore-listed.

Mineral Fuels

Coal, petroleum, natural gas and by-product gasoline are the mineral fuels listed in preceding summary. As shown therein, these four products account for 54% of all the business originating within entire mineral industry.

No state can surpass the known resources of Wyoming in this most important division of the mineral industry. The B. T. U.'s laying dormant in her known reserves of mineral fuels are approached by no state. Her reserves in coal, the most important mineral known to mankind, are the greatest in the nation.

Three states probably contain larger oil and gas reserves than Wyoming. The areas of two of those states, California and Texas, are respectively 1½ and 2½ times as large as Wyoming.

In volume the fuel division of the mineral industry greatly exceeds the total business produced by all remaining departments. Wyoming leadership in this most important of all divisions is of an incontestable order. In event all oil and gas reserves of the nation would be exhausted, it is comforting to know that elsewhere in the world these gaseous and liquid fuels are now being manufactured from coal types that predominate in Wyoming. For all demands

that may arise for manufactured fuels, the State of Wyoming can provide limitless raw material.

Steel Making Materials

The four products of preceding table consumed by the steel industry are pig iron, coke, iron ore and ferro-alloys.

Production of foregoing materials accounts for 20% of the activities of the mineral industry. Three of these products are manufactured materials, but nevertheless, they are classified in the table of the Bureau of Mines as the third, fifth and fifteenth leading products of the mineral industry.

So far the activities of Wyoming in the steel industry have been limited to the mining of ore. This ore is shipped to a neighboring state, where it is smelted and subsequently consumed in the manufacture of most of the steel produced within the entire area that lays west of the Mississippi River. Without the high grade ore of Wyoming, the establishment of a sizable industry within this greater half of the United States would have been extremely difficult.

Former State Geologists have maintained that the Newcastle district has heavy seams of coal suitable for coke manufacture. If their claims are correct, Wyoming contains all three ingredients, ore, fuel and limestone, that enter into the blast furnace charge. At present, Alabama, the fifth largest producer of pig iron, is the only state in which is mined and quarried all of the raw materials consumed by its blast furnaces. Had Alabama been unable to supply all requisite ingredients, she never could have induced the steel industry to locate a second Pittsburgh within her borders.

In course of time Wyoming should even surpass the present record of Alabama. A state that merely contains ore, fuel and fluxing material can no longer be considered a completely self-contained area in the complete metallurgical sense. In addition to preceding trinity of basic materials, there happens to occur at Iron Mountain, Wyoming, a vast deposit of iron ore in which government analyses disclose a total content of 27.47% combined oxides of titanium, chromium and manganese. In magnitude and in content of not one, but three of the extremely valuable metals that

enter into the modern ferro-alloy industry, the giant deposit at Iron Mountain is in a class by itself.

To make purer and stronger steels, increasingly larger quantities of the ferro-alloys are annually demanded. In addition to Iron Mountain, other deposits occur in the State suitable for the manufacture of chromium, manganese, phosphorous, silicon, uranium and vanadium ferro-alloys. The business of this branch of the steel industry is constantly expanding. According to prior summary of Bureau of Mines, the new ferro-alloy industry already overtops gold or silver production in United States.

Wyoming's colossal reserves of costly alloy ores should provide the fourth factor in attracting a modern steel industry to the State. At any event, her potential supremacy in "Steel Making Materials," the second division of the mineral industry, appears to be as complete as that previously described for "Mineral Fuels."

Building and Structural Materials

As disclosed by preceding table, the quarrying and preparation of clay products, cement, stone, sand and gravel, gypsum and lime accounts for 17% of the business conducted annually by the mineral industry.

All of these building and structural materials occur in Wyoming in limitless volumes. In reality it is these six materials that compose the Rocky Mountains in this State. So long as these magnificent mountain chains endure, no shortage of supply will likely loom in the offing.

To attempt to calculate the rock-mass of Wyoming would be ridiculous. Only one estimate is possible. In previous Chapter V, Wyoming was ranked as second in stature among the states. While the difference is almost imperceptible, nevertheless, honors in the third division should rightfully be awarded to a neighboring state, at least insofar as visible supplies of raw materials are concerned.

A few years back a facetious appraiser would have likely carried the value of all this rock on the Wyoming inventory at the nominal sum of $1.00. Such a procedure can no longer be justified. It appears that the Wyoming varieties possess qualities decidedly superior to those of the

CHAPTER XVII

A BRIEF RESUME ON THE ECONOMIC RESOURCES OF THE GREEN RIVER VALLEY

Indebtedness to Old Sol—Total Quantity of Minted Solar Energy Is Incomprehensible—Oil Shortage Alarms No Longer Scare—Unsurpassable Site for Nitrate Manufacture—Other Energy Potentials Briefly Cataloged—The Green River Valley Has No Competitors.

The day is dawning when the entire Green River valley of Wyoming will be rightfully recognized as the one and complete, giant natural powerhouse of all America. Within the favored Wyoming basin that occupies one-seventh of the area of the State, every known form of fuel as well as every basic physical or chemical agent so far utilized for the mass production of energy is consolidated in vast and unrivaled volumes.

Indebtedness To Old Sol

For countless milleniums, Old Sol selected the Green River valley as a titanic, rock-ribbed, strong-box to store away his vastly greater surpluses of radiant energies that he dispensed in the geologic past. From the decay of floral life once sustained in the fabulously fertile valley the greatest known coal deposits, officially totalled at 665 billion tons, now form the fossilized remains. From the decay of faunal life that ranged in size from microscopic protozoa to the largest of the dinosaurs, the end results of bio-chemical and geological activity have produced all of the gas and oil fields as well as all of the huge deposits of petroliferous shales, phosphates, potashes and nitrogenous compounds now amassed and agglomerated in overlapping manner within the consummate and inimitable Solar Storehouse of Wyoming, aforesaid.

Total Quantity of Minted Solar Energy is Incomprehensible

To calculate the sum total energy contained in the Wyoming wonder valley is still unthinkable. Aside from Wyoming, no single state can exceed the Green River basin in total coal reserves. The latent energy now reposing in its 665 billion ton coal-bin is unexceeded by the entire water power potential that will be developed in America in the next 3,000 years. At the present day much is heard of the mineral wealth now being recovered from Pennsylvania, Oklahoma, California, Texas and West Virginia. In terms of horsepower, more energy is contained in the coals of the Green River valley than will ever be extracted from all known coal, oil and gas fields situated within all five of the greatest fuel and mineral producing states of America, above-mentioned.

If further advancement and concentration is made along the lines of power mass-production and nation-wide interconnection the solid fuels of a little known Wyoming valley will be found amply lasting to turn the wheels of America for 500 years. Obviously, until a less toilsome age arrives wherein all work will be performed by mechanical Robots, no true appraisal of these limitless power reserves will be probable.

Oil Shortage Alarms No Longer Scare

In recent years many alarms have been repeatedly broadcasted in regard to the early and immediate exhaustion of the huge oil deposits of America. Such a dubious catastrophe no longer worries the directorate of the Standard Oil Company of New Jersey, the greatest of all oil producers in America. Recently, that billion dollar corporation purchased the American patent rights to make synthetic gasoline from the hydrogenation and liquefaction of inferior coals as covered by the German process of Dr. Frederich Bergius. Already this company has financed one quarter the cost of construction of a huge plant in Germany, a nation barren of petroliferous deposits, in which 30,000 men are now employed in manufacturing oil by pumping hydrogen obtained from water into low-grade coals at high pressures and temperatures. In a despatch printed last fall in a leading Wall Street publication the giant New Jersey

corporation was reported as being ready for the erection of another plant for the expressed purpose of developing the new process within the United States. As coal is the only raw material consumed in the operation, it is evident that no site in America could possibly offer comparison to the Green River valley as the logical location for the first oil manufacturing plant in America. Therein, lignitic coals suitable for oil making could be mined with steam shovels at the lowest possible costs, and even if all of the oil fields of the nation should become exhausted, the local coal deposits happen to be of sufficient magnitude to meet American requirements for motor fuels for many generations yet unborn.

Wyoming is no longer appalled in regard to national oil exhaustion alarms of periodic recurrence. Thanks to progress made in recent science, one valley in Wyoming would prove to be the salvation of the nation if an oil shortage would actually develop. Considering the vast construction programs now under way on the part of our giant oil and chemical companies, the time is finally here to broadcast the unsurpassable merits of the fuel and chemical deposits of Wyoming. Unless such steps are soon taken, billion dollar aggregations of private and public capital may continue to commit economic errors of a gravity and magnitude previously mentioned herein. In other words, the day has finally arrived for energetic Wyoming to get a premier location on the industrial map of the world.

Unsurpassable Site For Nitrate Manufacture

Heretofore, the manufacture of nitrogen compounds, the foundation of the national food supply, was, likewise, defined as a process that consumed titanic stores of energy. For the production of one ton of nitrogen compounds, as much as 11 tons of coal are consumed. Manifestly, for the nitrogen demands of the nation, no single coal-box could withstand the required inroads as long as the Green River valley, the greatest and most lasting depository of multiplex forms of energy known in the United States. In this chemical and mechanical age, the supereminence of the Wyoming valley must soon be demonstrated materially.

Failure to learn of its superlative advantages may prove decidedly disastrous on the part of giant industrial enterprizes, already organized.

Other Energy Potentials Briefly Cataloged

Immature prospecting precludes the possibility of filing a complete appraisal on the total oil and gas resources discovered within the fabulously rich valley during the past year and before. During last month contracts involving total expenditures of $18,000,000, were let for the construction of a 200 mile pipe line to convey natural gas from two recently discovered reservoirs to Utah municipalities in which over half the population of that adjoining state now reside. Manifestly, if the Wyoming valley is to be converted into one huge workshop at an early date, much of this ideal fuel of an incomparably high calorific value should remain at home.

In terms of kilowatts or horsepower, it is, likewise, impossible to evaluate the energy content that is now entombed in the hardened remains that form the phosphate, potash and nitrogenous deposits of the incomparable Green River valley. These rock deposits totalling several hundred million tons assure America of an ample supply of all mineral forces that her entire realm of plant life can possibly consume for many decades and centuries yet to come. For the direct conversion of these raw chemicals into the valuable super-double-salts of modern commerce, construction of the 71,000 continuous horsepower hydro-electrical proposal of the Government should no longer be delayed on the local river channel.

The Green River Valley Has No Competitors

In the lowly lavas, shales and beds of carbonaceous, petroliferous and chemical remains that literally compose the mountain masses of the valley, as well as in the channel of the precipitously descending Green, every form of energy, fuel, and mineral resource typical of the Niagara, the Allegheny, the Ruhr and a dozen more of the great industrialized valleys of the world is present in truly colossal volumes. In the distant valleys mentioned, only one or two forms of raw materials or power resources are gen-

erally found. Only within the Wyoming basin are all of the basic energizers consolidated within a single area. In course of time these little known resources will release multitudinous forms of energies and vitalizing forces that will dwarf the sum total now being generated within a dozen of the most highly industrialized valleys of the world. No comparisons are possible for the Green River valley. To write the future of this supremely favored valley, time, in lieu of any existing precedent must alone tell the story.

Sound Foundations Already Laid

It would indeed require a daring prophet to foretell just how soon complete industrialization of the wonder Green River valley will eventuate. As developments now stand, the span of but two generations separate the far famed valley from the dominion of the buffalo and the Indian. In the intensely developed industrial valleys cited in the prior comparisons, similar domination ceased in periods at least from three to thirty times as distant.

Far more acceleration will take place in the industrialization of the Green River valley. Today, the Lincoln Highway, the main street of the nation, crosses the complete width of the valley. Also, for the construction of the first transcontinental railway system, the first coast-to-coast telegraph and telephone lines as well as the present sea-to-sea air mail line, the favored route of the Green River valley was in every instance selected.

At the present time, the successive entrance of all conceivable types of main arterial highways and carriers into the valley is merely looked upon as preliminary ground-work in the logical development of America's greatest industrial empire in the making.

CHAPTER XVIII

MINERAL FUELS

INTRODUCTION

No state contains a greater variety or quantity of mineral fuels than Wyoming. In order of value oil, coal and natural gas form 95% of the entire mineral wealth produced in Wyoming at the present time.

The importance of these leading mineral resources of Wyoming can hardly be over-estimated. For conversion of lowly raw materials into valuable finished products, these basic fuels form the bone and sinew of all giant industrial processes. These three energizers also produce the force that turns the wheels of the nation. Indeed, without a superabundance of one of these fuels, it would have been quite impossible for luxurious America to acquire ownership of 85% of all motor cars in operation in the world today. To her unrivaled wealth of primary power producers the supremacy and leadership of America is due far more so than to any other single factor that could be mentioned.

As a future powerhouse for all America, it would be impossible for any state to challenge the premier position finally accredited to Wyoming by the United States Geological Survey and other fact finding agencies. In ultimate terms of British Thermal Units or kilowatts, the combined fuel and power resources of the single state of Wyoming equal 20% of the nation's known reserves.

The future of Wyoming lies almost entirely in the development of her matchless wealth of fuels and power producers. To one who deals in realities rather than in names, the great mineral producing states of the Union are not those in which the greatest tonnages of gold, silver, copper, lead, zinc, iron or all other metallic ores are mined. Last year, Pennsylvania, the leading coal producer of the nation,

was the only state in which total mineral production exceeded one billion dollars. The remaining states able to reach the extremely select bracket of one-half billion dollars were Oklahoma and California, the two states in which the greatest volumes of oil and gas were produced. Containing more fuel reserves than all three of the present giant producing states of the nation, even the gloomiest of pessimists must admit that no area could possibly offer more room for expansion than the wide open spaces of Wyoming.

Heretofore, a number of industrial processes were reviewed that consume titanic stores of energy. For their successful operation, no site could offer lower production costs than the varied and limitless fuel depository of Wyoming. In subsequent chapters the character and extent as well as industrial potentialities of these multifold and exhaustless supplies of energy receive more explicit attention.

ization proposes to mine a giant horizontal seam of coal, reported 60 feet in thickness, by the aid of a fleet of steam-shovels. Manifestly, for excavating coal at the lowest possible cost and for greatly multiplying the output per man employed, no conceivable scheme of operation can approach the plans contemplated by the most modern of all Wyoming coal companies.

Instead of loading the steam-shoveled coal on cars for shipment, the plans of the company actually propose the burning of the fuel in huge boilers to be erected at the pit-site for direct conversion into electricity. This electrical power will be supplied to towns of the Gillette region as well as to the most important cities of western South Dakota. The largest gold mine of the United States, the Homestake, situated 100 miles east of Gillette, already uses Wyodak coal. However, the engineers of the coal company have ascertained that coal can be converted into electricity at the Wyodak stripping operation, and the power transmitted to present South Dakota market points more economically than coal can be hauled to that adjoining state and there converted into power.

Probably, no operation now under way will disclose the titanic industrial possibilities of Wyoming in a more profound and revolutionary manner than those already being effected by the little-known, pioneer Wyodak company. Within the next score of years the present methods for shipping coal to be burned under boilers hundreds of miles from the mines will surely appear rudely unscientific and hopelessly out of date.

In 1927, the outstanding feature in the growth of the giant electrical industry was the development of the mass production of power. Coupled with the completion of large, steampower, generation stations was the further extension and expansion of interconnected transmission systems which now reach from the Mississippi River to New England, and from Lake Michigan to the Gulf of Mexico. Yearly, the gap narrows between the giant coal seam of the Wyodak company and the rapidly expanding power system lately massed and interconnected into a single unit throughout the eastern half of the United States. To provide cheaper and more re-

liable service, all that the existing system requires is a power-line tie-in to a huge steam-shovel coal operation in Wyoming. When that day comes a market of worth-while magnitude will be directly on hand for the pioneer operations now being conducted by the Wyodak Coal and Manufacturing Company at the strategically located site of Gillette, Wyoming.

FUTURE INDUSTRIAL POSSIBILITIES

Electrical power is not the only commodity now being transmitted directly from the mouth of the mine to the consumer. Already, the complete gasification of coal is an accomplished fact. At the present time Germany is concentrating in the single Ruhr Valley coal field the entire artificial gas industry of the country and effecting nation-wide distribution through the network of high pressure conduit lines leading therefrom. At the Second International Conference on Bituminous Coal held last November in Pittsburgh, representatives of the German Institute of Coal Research described the problems mastered in the development of these revolutionary processes. For practical application of the new process in America, the coal that can be mined at the lowest cost in Wyoming will doubtlessly be found to possess the most potent possibilities, at least for markets that will later develop in the metropolitan centers of the Missouri and Mississippi valleys.

During the past year the State Geologist has repeatedly stressed the unsurpassable advantages that Wyoming offers for establishment of the latest coal processing plants. At the recent International Conference, similar observations were expressed for the first time in open forum. In a paper read by the President of the Armour Fertilizer Company, it was likewise maintained that the lignite coals of the Northwest were best suited for conversion into gasoline as well as for the manufacture of ammonia and other products consumed by the fertilizer industry. As the Wyoming coals lay nearest to the great consuming markets, and inasmuch as these huge seams could be steamshoveled at the lowest costs, it can be safely concluded that no sites are superior to those

of this State for the location of new industrial enterprises of the character already operating in Europe on large production schedules.

In America, modern coal technology is rapidly approaching the threshold of big developments. For practical application of major developments already commercially operative in other parts of the world, no state can possibly excel the manifest pre-eminences of Wyoming. In the preceding Mineral Fertilizers chapters the technology of some of the latest fuel processing industries were reviewed. At the conclusion of the section a brief resume was filed on the present upper-hand that America's greatest coal field, the Green River basin, holds for the immediate establishment of giant fuel processing plants.

CONCLUSION

In our present mechanical and industrial age, coal is the most useful of raw materials with which man has been endowed. More coal is mined annually in the United States, the giant power consumer of the world, than all other minerals and ores put together. We hear much of the increasing oil production of the day. According to Dr. Fieldner, leading coal technologist of the Bureau of Mines,—"if all the oil now obtained from the American wells were made from coal by the Bergius process, our present bituminous coal production would be increased about 60 per cent."

Coal is still King of the entire mineral realm. The supremacy of Wyoming in this most valuable and indispensable of all raw materials would appear to augur well for her future.

BIBILIOGRAPHY

For many years the United States Geological Survey has conducted exhaustive and complete studies on the geology of Wyoming coal deposits. For preparation of this chapter their publications were frequently referred to. The bibliography of their publications on Wyoming coal fields follows:

Abbreviations used:
B—Bulletin
P—Professional Paper
GF—Geologic Folio

CHAPTER XX

OIL

Two Types of Oil—Past and Present Production—Production Rank—Wyoming Has 200 Recognized Oil Structures—Room for Discovery of 200 Additional Oil Structures in Wyoming—Other Sources for Future Production—Petroleum Technology Is Not a Stationary Art—Recent Examples of Deeper Drilling in Wyoming—Applied Geophysical Practice—Present Reserves—Bibliography.

The second great mineral asset of Wyoming is petroleum. During past ten year period oil production has exceeded the value of coal production by more than 200 per cent. If production is maintained at recent levels, oil will soon overtake coal in value of total output. In value of known reserves the huge coal deposits of the State will always vastly exceed the prospective contents of the many oil structures so far mapped in Wyoming.

Two Types of Oil

Wyoming oils are of two kinds, the light colored green and brown oils of high Baume gravity and paraffine base, and the heavy black oils that contain an asphaltum base. By far the greatest production in values are in the light oils, from which high gasoline extractions are obtained. Generally speaking, the light oils are found in formations of the Cretaceous system and the black oil comes from much older rocks, principally in the Permian and Pennsylvanian periods of the Carboniferous system. Due to their lower gasoline content the black oil pools of Wyoming are not exploited in an intensified manner. At present these little developed fields can be considered as valuable reserves in event an oil shortage would actually occur in the nation.

PRODUCTION

Past Production

Before 1915 oil production in Wyoming was of insignificant volume. In the past five year period, production ranged from 21,000,000 to 44,785,000 barrels annually. During present year, the total recovery from the Salt Creek pool passed the 200,000,000 barrel figure. At the end of 1928, the total oil production for Wyoming for all time will approximate 296,000,000 barrels. For long intervals fair prices were not procurable for the high grade oils of Wyoming. Nevertheless, for all oil so far produced, a sum close to $432,000,000 has been received.

By far the greater portion of the oil produced in Wyoming was from lands belonging to the State or National Government. Since 1920, the State received either direct or joint royalties from all public land production ranging from 5 to 65 per cent. To date these colossal operations on public lands have poured into the State and National treasuries over $58,000,000 in royalty payments, alone. Manifestly, the continuation of this golden stream is of vital importance for the future welfare of our State.

Present Production

For the total production of 1927, the following summary, that lists each field separately, was prepared by the State Oil and Gas Inspector; and from reports to State Board of Equalization:

Wyoming Oil Production, by Fields, in Year 1927

Field	No. Wells	Barrels
Big Muddy	188	1,063,657
Black Mountain	6	7,581
Bolton Creek	5	1,802
Byron	10	19,555
Dallas Dome	38	75,394
Derby	4	9,284
Dutton Creek	1	7,389
Elk Basin	145	224,783
Ferris	23	22,089

Field	No. Wells	Barrels
Grass Creek	346	973,645
Greybull	6	6,482
Hamilton Dome	27	391,082
Hudson	32	129,217
LaBarge (Sublette County)	28	240,231
LaBarge (Lincoln County)	17	87,616
Lake Creek	2	3,949
Lance Creek	26	279,478
Lost Soldier	73	1,294,188
Maverick Springs	27	454
Mule Creek	41	186,398
Notches	3	24,107
Oregon Basin	31	5,122
Osage	89	100,235
Pilot Butte	27	17,422
Poison Spider	19	20,321
Rex Dome	4	43,546
Rock Creek	61	972,177
Salt Creek	2125	14,302,733
Simpson Ridge	7	24,476
South Casper Creek	19	218,994
South Sunshine	1	5,886
Spring Valley	16	873
Teapot	63	295,702
Torchlight	50	756
Miscellaneous		89,869
	3560	21,146,493

For 1928, oil production should be 22,000,000 barrels plus or minus 100,000 barrels. This 700,000 barrel increase over last year is not in agreement with some forecasts recently made.

As yet, some residents have not formed a definite concept of the comparative importance of the oil industry in Wyoming. Outside of United States, only Mexico, Russia, Venezuela and Persia exceeded the Wyoming total in oil production during the year of 1926, for which year international statistics are now complete. Had all of the oil of these

four leading foreign nations been pro-rated among the teeming millions that reside therein, a mere pittance of a few cents per individual would have been so distributed. On the other hand, if a similar distribution had been made in Wyoming, the funds available would have quite sufficed to donate each Wyomingite the sizable sum of $200.00 or more. Manifestly, Wyoming's second position in per capita wealth among the 48 sister states need no longer remain a mystery. Thanks to our giant oil industry, it would indeed be hard to conceive of a soil less fertile for the introduction of the tenets of Sovietism than Wyoming.

PRODUCTION RANK

During the past ten year period, Wyoming has ranked in fifth and sixth places in oil production within the United States. At the present time, Oklahoma, California, Texas, Kansas and Arkansas are the only states that produce more oil than Wyoming.

In per capita output it is still impossible for any of the giant oil producing states to approach the premier record of Wyoming. Much is heard of the flow of liquid gold yielded by the primary oil industry, especially in these days of rapid transport by motor and plane. But getting down to brass tacks, the indisputable fact remains that in no part of the globe does this most romantic of industries comprise a greater portion of the economic fabric, or put more money in the bank per individual citizen, than it does right here within the confines of the Sovereign State of Wyoming.

Other analogies, ad infinitum, could be drawn from the wonder oil industry of Wyoming. In lieu of the few, the extremely profitable industry is conducted almost exclusively for the benefit of the many in Wyoming. In other great producing areas the obscure land-owner may be transformed into a millionaire over-night. In Wyoming, precisely identical strokes of good fortune are directly diverted into the common treasuries of the people, and the proceeds immediately expended in financing higher cultural attainments in the way of better roads, better schools and better universities. Also, some of the more optimistically inclined

tax-payers even predict that in course of time these public proprietorship funds will accumulate to sufficient magnitude to finance bigger and finer irrigation projects directly within Wyoming.

KNOWN AND UNKNOWN STRUCTURES

Wyoming Has 200 Officially Recognized Oil Structures

On the oil field map published in 1921, the locations of 193 plausible oil or gas structures in Wyoming were plotted by the United States Geological Survey. At that time approximately 60 of these structures were either producing or else known to be capable of production by development operations then completed.

Drilling operations since conducted have discovered oil or gas in at least 17 additional structures, the majority of which were plotted on the former map of the Government. As yet some of the biggest gas fields are not connected by pipe-lines, and production from the more remote black oil pools will also remain shut-in until a better market can be developed for that neglected commodity in this State. Moreover, the nation is fully aware of the litigation that has kept the name of one of Wyoming's light oil structures in newspapers throughout the past seven year period.

For various reasons not all of the structures so far mapped by the Government and other agencies have been tested with the drill. For drilling operations in the years to come, plenty of prospective fields and wildcat territory remain in this State.

Abundant Room to Discover 200 Additional Oil Structures in Wyoming

Unlike other great oil producing states, nearly all of the great oiltraps so far recognized in Wyoming are sufficiently visible to serve as text-book classics for the novitiate to acquire his first knowledge of petroleum geology. Many of the domes stand out in such bold relief that their general decipherization was a comparatively simple affair on the part of our sheepherders, and other passers-by as soon as petroleum geology was elevated to the status of an exact

science during the year of 1915 or thereabouts. As yet, oil exploration in Wyoming has barely advanced beyond the exploitation of structural types of the visible character briefly outlined in preceding remarks.

Unfortunately, over half of the surface area of Wyoming is generally overlain with a huge mantle of horizontally laying Tertiary deposits. Within this greater half of Wyoming are buried anticlinal axes that no geologist will ever visualize. Obviously, the discovery of these completely obscured structures will not be as facile a task as were the locations of existing producers that generally loom above the horizon in a manner quite unescapable to the eye.

Some geologists are of the opinion that 200 additional oil structures are covered by the huge Tertiary deposits of Wyoming. From an areal view-point their line of reasoning would appear to be conservative. Moreover, latest advancements in geophysical practice may serve to establish some of their contentions. But whether or not a second Salt Creek is buried under the valley-fill of the Big Horn Basin; the huge Gillette Basin, similarly rimmed with known oil structures; as well as other large gathering areas like the Red Desert, it would seem that nothing short of the drill will suffice to tell the final story. In the big producing states less fortunate in visible oil structures, prospective areas can only be geologized with the aid of the drill. Obviously, in course of time, equally costly exploratory work will have to be conducted in Wyoming under the direction of the geological staffs of the large oil companies.

OTHER SOURCES FOR FUTURE PRODUCTION

Petroleum Technology Is Not a Stationary Art

Many tomes recently digested on the possible oil reserves of Wyoming are of a decidedly misleading character. In the past some writers have labored under the assumption that the technology of the giant industry had already reached a maximum state of perfection, and that in the years to come, no further improvements would be devised for the extraction of the oil content still suspected of reposing in the deeper sedimentaries at many points on the

globe. Herein, the present talent employed by the industry is held in higher esteem.

Beforehand, it should also be understood that the geological estimates referred-to, carry but little argumentation of a convincing character against the teachings of certain modern schools of economists. According to the views of the latter gentlemen, improved technical practice and the increasing market demands of the nation are now each engaged in a race for supremacy. At the present post the first named contestant appears to be well in the lead in the titanic industrial marathon now under way.

Deeper Drilling

In recent years deeper drilling and improved recovery technology, both at the well and in the refinery, can chiefly be accused of over-flooding the market with petroleum products. This month oil was discovered in Texas at the record depth of 8,516 feet. That is a long cry from the 3,000 foot holes of yesteryear. Obviously, if similar practice is adopted in Wyoming, some of our larger fields might yield production from a dozen sands in lieu of the half-dozen now being exploited.

Recent Results in Wyoming

Within past two years the benefits of deeper drilling were demonstrated in Wyoming in a decidedly material manner. One of the first structures tested in Wyoming was the Oregon Basin. In 1917 a test hole drilled to a depth of 1,600 feet brought in gas. Due to this disappointing showing, the potential field was permitted to lay idle until two years ago, when a hole drilled to 3,700 feet brought in heavy gusher production from a big-pay sand. Since then, the long abandoned field has been directly instrumental in adding the millions of dollars recently accredited to the assessment rolls of Park County, Wyoming.

Another more recent example in the same locality is the Frannie structure. In 1919, this anticline was drilled to a depth of 2,374 feet with totally disappointing results. Last summer a hole but 209 feet deeper struck a heavy flow of crude in the penetrated Embar formation. As a conse-

quence, the old Frannie anticline is now esteemed at an extremely fancy figure.

Deeper and deeper drilling tests should be conducted in Wyoming. In the future, territory heretofore considered unpromising will be tested to greater depths. In view of the gratifying results previously commented upon, more and more deep drilling campaigns will do their part in keeping Wyoming on the oil map of the world.

APPLIED GEOPHYSICAL PRACTICE

A new recruit has recently been enlisted by the rapidly advancing oil industry of the globe. The rock-hound with his wide-brimmed Stetson, shiny leather puttees, may soon follow the footsteps of his even more picturesque predecessor, the cowboy of the Wyoming plains. Today, the prestige of the former gentleman is gradually being eclipsed by the be-spectacled geophysicist who may carry doctorate credentials from a half-dozen international universities by virtue of original work performed in the deeper sciences that usually include the last word on wave transmission, radio-activity, electronic theory, Einsteinism and the like.

For eliminating useless drilling costs in barren areas and for general investigation of subsoil structure by the aid of elastic waves, gravitational contrasts, and electrical phenomena, the latest petroleum pathfinder employs instruments as widely divergent as the seismograph, the torsion balance and the magnetometer. As late as three years ago, talent for the interpretation of the highly sensitized readings that these devices are capable of recording was generally confined to the more advanced geophysical observatories of Europe. In recent years, however, our higher universities have been turning out an increasing number of recruits ever more skilled in the use of the several instruments referred to.

For conducting latest scientific surveys, the Wyoming terrain is still virgin territory. In other words, the savant has not yet exhausted all available means that can be used for arriving at the sum total oil and mineral resources that were laid down within the wonder Wyoming depository dur-

ing the countless aeons of endless time. As yet, neither the geologist nor the geophysicist has concluded his work in Wyoming. On the contrary, his labors have not even started, that is, if the deepest scientific use of the word is alone construed.

PRESENT RESERVES

For a long time the figure of one-half billion barrels has officially served for the existing oil reserves of Wyoming. Owing to the many unknowable factors of the order briefly touched upon under preceding headings, as well as the divers other adjustments that commonly enter into the calculations of the forecasters, no estimate on the present oil reserves of Wyoming will appear in this review.

GEOLOGICAL PUBLICATIONS

Owing to the amount of original material that was inserted in this chapter, no room was left for detailed geological discussion on even our largest oil structures. Information of this character can be procured elsewhere. For the 15 years last past, members of the United States Geological Survey have conducted exhaustive investigations of the leading oil structures of Wyoming, and all of their valued publications on this subject are generally in the possession of the private geologists now practicing in this State. These publications are listed below. Should the reader refer to a number of these Survey volumes, the incapacity of the writer to condense their contents into this brief chapter, or even this entire publication, will be more easily understood.

Abbreviations used:
A—Annual Report
B—Bulletin
P—Professional Paper

CHAPTER XXI

NATURAL GAS

Revenue—A Mining Comparison—Production Rank—Present Completions—Pipeline Network—Future Development—Present Interstate Development—Industrial Possibilities—Advertising Sometimes Pays.

One of the largest and most promising undeveloped resources of the State is natural gas. Annual consumption of this unsurpassable fuel is over 30 billion cubic feet. Its use is constantly expanding. At present Wyoming burns more gas in a single day than was consumed in an entire year as late as 17 years ago. Room for further expansion is considerable. According to recent estimate the combined gas fields of the State are capable of producing a billion cubic feet a day, which volume equals 12 times consumption demands already developed.

REVENUE

Total sales of natural gas in Wyoming exceed $4,000,000 annually. The yearly recovery of by-product gasoline from the exceedingly rich gas amounts to 43,000,000 gallons, for which nearly $3,000,000 additional is received. Carbon black, the only other product manufactured from gas, brings in an additional annual revenue of $100,000. In volume of sales, the gas business is surpassed only by petroleum and coal among the mineral industries of the State.

A MINING COMPARISON

In monetary value, the gold production of only one state, California, now exceeds the gas production of Wyoming. Within two years, sales within this new and rapidly

expanding industry will surpass the gold production of the leading state mentioned. In truth and fact, if sufficient outlets were provided, a gas business could be developed in Wyoming of greater magnitude than the entire gold mining industry of the United States, including Alaska.

Already, the profits yielded by the Wyoming gas industry are of sizable amounts. In volume they are rapidly approaching the net returned from all the gold mining operations conducted in the nation. As yet no records are available of an unsuccessful gas development within the public utility field of Wyoming. To home or outside capital seeking safe investment at high returns, plenty of opportunities still remain within the dominating and potential mineral empire of Wyoming.

PRODUCTION RANK

At present the gas production of Wyoming is exceeded by seven states. In no state, however, is this important industry developed in a more intensified manner than here in Wyoming. It is extremely doubtful if any state ever will aspire to equal Wyoming's present record in gas consumption per individual. Moreover, per capita consumption in Wyoming will greatly increase in the future without seriously disturbing the volume of undeveloped reserves now known in the State.

At present, nearly all the gas produced is consumed in the State. When pipeline construction now under way is completed, sales to outside states will soon equal the market demands already developed within Wyoming.

EXTENT OF PRESENT COMPLETIONS

Coal firing together with other equally archaic symbols of the previous centuries are rapidly becoming lost arts in Wyoming. In lieu of the drudgery of yesteryear, the home of Mr. Average Citizen is now heated with a thermostatically controlled gas furnace, the operation of which requires a few minutes attention within the course of one year.

Naturally, this latest form of heating service is rapidly expanding. Towns and cities already connected by pipeline with the huge gas-fields widely distributed throughout the State include, in order of installation of service, Basin, Greybull, Byron, Lovell, Cowley, Midwest, Casper, Powell, Rawlins, Riverton, Lander, Hudson, Thermopolis, Rock Springs, Parco, Parkerton, Glenrock, Cody, Cheyenne, Grass Creek and Worland. In addition to these cities, Billings, Laurel, Fromberg and Bridger, Montana, are also supplied with gas from one of the large fields of Wyoming.

Present Pipeline Network

To finance the gas service already installed throughout Wyoming a large amount of capital was expended. Present connections involved the laying of 1,179 miles of pipelines. The existing net-work consists of 755 miles of trunk-lines, 137 miles of gathering lines, and a distribution system aggregating 287 miles. To complete these lines, an investment of over $11,000,000 was required. For their faith in Wyoming, far seeing investors, originally from outside states, have already reaped princely rewards in establishing public utility service of the highest merit in this region.

FUTURE DEVELOPMENTS

Other Wyoming Cities Will Soon Burn Gas

Natural gas is already piped to most of the important towns and cities of the State. By proposals already under construction or else feasible for development at a comparatively early date, Evanston, Green River, Laramie, Douglas, Buffalo and Sheridan will be the next cities to receive gas service in Wyoming. If all proposals are completed, every town in Wyoming over 3,000 in population will enjoy the most efficient and modern form of fuel service so far known. Manifestly, in no other state are the gas reserves of sufficient magnitude to provide a service so wide and intensified.

INTERSTATE DEVELOPMENT

Wyoming is the only state known to contain a supply of highly efficient gaseous fuels far in excess of present

market requirements. Less fortunate states will not always permit these priceless resources of Wyoming to remain idle. Within past week contracts, involving total expenditures of $18,000,000, have been let to construct a 200-mile long pipeline from two big gas fields in the Green River valley to municipalities in Utah in which over half the population of that adjoining state reside.

With one exception, the new pipeline will be the longest line constructed in Wyoming. Completion will involve the unloading of 3,000 car loads of 18 inch pipe, each section of which is 30 feet in length and of 3,000 pounds weight. For completion by July 1, 1929, the services of 200 trucks and 1,000 workers will be required. For actual development of the natural gas resources of Wyoming, other operations of equal or greater magnitude will be conducted from time to time.

INDUSTRIAL POSSIBILITIES

In previous chapters Wyoming's supremacy in basic power producers was described. For driving gasoline motors her typical petroleum production, the light oil crudes, was found to contain the highest potentials. Again, for the generation of electricity, the most modern form that power can be applied in the industrial field, both the high gradient river channels and the enormous coal seams of the State were found to possess unprecedented possibilities for low cost development.

From all of the preceding energizers heat can, likewise, be produced. But for modern heat generation no agent is more efficient and ideal for direct application than Wyoming natural gas. In calorific value the Wyoming wonder fuel is worth twice any manufactured gas that is made and consumed in the large cities of America.

Wyoming's huge deposits of both heat and power producers provide tremendous advantages for future industrial expansion. Her immensely valuable gas resources offer a standing invitation for pottery, porcelain, glass, brick, tile and other ceramic industries to locate in this State, especially since the raw materials used by these industries occur

in exhaustless quantities either in or near huge gas fields. In eastern and central states such industries were long ago established in the midst of former gas structures. As the source of their fuel supply dwindles, Wyoming fields will gradually provide more feasible locations for new plants and replacements.

Again sight should not be lost of the new products that technologists are continually creating directly within the gas industry itself. In West Virginia, natural gas is now the basis for the manufacture of a wide range of organic chemicals of complex molecular structure which include acetone, solvents used in rubber and lacquer industries, ethylene glycol, the basis of Prestone which is the trade name for the new and highly superior radiator anti-freeze nationally advertised for the first time this winter, and also, the new Pyrofax gas for household use.

Until more gas technologists visit Wyoming, it will be quite impossible for all of her citizens to enjoy the conveniences derivable from the use of her most superior fuel. To burn gas it is no longer necessary for the household furnace to be directly connected by a pipeline to a big geologic reservoir distant from 10 to 100 miles therefrom. To eliminate the latter costly installation, said householder now buys a can of Pyrofax. This Pyrofax is simply natural gas compressed in same style steel cylinder in which sodawater merchants and oxy-acetylene welders purchase their respective carbon dioxide and oxygen supplies.

About 3,000 cubic feet of natural gas is compressed into these cylinders. For cooking, heating and lighting in small homes the highly concentrated unit should outlast two or more weeks. In Wyoming, the best market for the new patented product would include the cabins and hotels of the mountain resorts, as well as the ranch homes that are not located near the existing pipeline network of the State.

For establishment of a compression and marketing plant, the city of Casper would provide the best site. From that centrally located outlet, lowest carriage charges would prevail on cylinder exchanges. In any event, any manufacturing operation that would directly aid the big dude ranch industry should prove doubly advantageous to the State.

erals also recovered from the mica seams and dikes. To date the latter minerals have been unsalable in Wyoming.

In the future the mica deposits of Wyoming will do their share in attracting important industries to the State.

MINERAL WATERS

Mineral waters, both hot and cold, are very numerous in many parts of the State. Most of them are said to contain valuable curative properties. These waters apparently have their origin in the beds of the Triassic and Permian series and contain lime, magnesia and soda as sulphates and chlorides, which salts are probably derived from these formations. The temperatures of the warm springs range from 90 to 140 degrees. The better known springs are located at Thermopolis, Saratoga, Cody, Fort Washakie, Alcova, Hailey, and in Granite Creek Canyon. In addition, mention should be made of the wonderful hot springs and geysers of Yellowstone Park, Northwestern Wyoming.

In recent years, no federal agency has made a separate and complete canvass of the production of mineral waters in Wyoming. The uses and sales of these products are known to be growing. In the future, these unusual resources will continue to attract constantly increasing income to the more widely known resort centers of the State.

SULPHUR

Native sulphur is found in considerable quantities near Thermopolis, Hot Springs County, and near Cody, in Park County. Both deposits have been mined to some extent and the product shipped. The sulphur occurs both in massive, practically pure form and in crystalline form disseminated in travertine. Sulphur and travertine were deposited by hot, circulating waters in the crevices and channels of dolomitic limestone. The deposits, therefore, are not solid and continuous, but are in pockets and stringers and lenses, and the low-grade disseminated material is far in excess of the pure, massive sulphur.

Other deposits of sulphur in these two counties and also in Fremont County have been reported. The hot springs district in Yellowstone Park also contains important sulphur deposits. Naturally, the scenic value of this matchless and far famed Wyoming region vastly exceeds the sum total mineral resources contained therein.

MINOR NON-METALLIC DEPOSITS

In addition to minerals already described, a number of other non-metallic deposits are known to occur in Wyoming. The market for some of these materials is gradually being replaced with the use of more modern products. In other instances, the demand for prospective products is so distant as to warrant no descriptions at this date.

For the names and locations of most of these deposits of slight economic significance, the reader is referred to the table in the appendix of this volume entitled—"Useful Minerals of Wyoming."

CHAPTER XIII

FERTILIZING MINERALS

INTRODUCTION

Few states or nations contain extensive deposits of phosphorous, potassium and nitrogen compounds. The salts of these three vital chemical elements form the grand trinity of mineral fertilizers consumed by plant life in attaining its organic growth.

So sparingly do the compounds of these chemical elements occur in nature that, heretofore, the world production of potassium and nitrogen salts have been international monopolies controlled respectively by the German and Chilean governments. In only one known locality do all three of these mineral fertilizers occur, side by side, in intremendous quantities. Incidentally, that locality lays in southwestern Wyoming, between the railway stations of Wamsutter and Cokeville.

So far the exploitation of the colossal reserves of mineral fertilizers in Wyoming has not even started. In the geologic past a floral and faunal life of unprecedented density was sustained in Wyoming. At the present time, no less than 20 million acres, or a full third of the area of the State, is underlain with coal, oil and gas deposits of unsurpassed immensities. At other places, skeletonized remains of the largest dinosaurs ever discovered were exhumed from the rock-tombs of Wyoming for final display in the great scientific museums that are maintained in the leading capitols of the world. The residual remains of the plant and animal life that once thrived in so grand and extravagant scale in Wyoming are known to total considerably over a trillion tons in the form of coal seams and mineral fertilizers alone. From these immense remains of organic origin, the soils of the State naturally become super-charged with record-

breaking contents of phosphate, potash, and other revitalizing agents of minor economic importance that are consumed by present-day, bio-chemical processes. Obviously, years and even centuries will pass before these extremely fertile soils can be depleted of their mineral contents. For that reason the future exploitation of Wyoming's vast reserves of fertilizer minerals must rest entirely on the increasing market demands that arise annually within older states and nations.

At the present time the American farmer continues to purchase the bulk of his mineral fertilizers from distant foreign nations. In addition to phosphorous, potassium and nitrogen, the seven remaining chemical elements essential to agriculture are carbon, hydrogen, oxygen, sulphur, calcium, magnesium and iron. In the complete Wyoming depository all of the latter elements of minor economic importance, likewise, appear in literally limitless volumes. The big problem of Wyoming at the present time is to devise ways and means to supply America and remaining nations with every variety of mineral fertilizer consumed by the giant agricultural industry of the world. Merely to list the names of the endless fertilizer chemicals that could be most cheaply manufactured in Wyoming would exhaust the space devoted to this paper. Under the subsequent headings only the geology, technology and commercial inter-relationship of our principal deposits are alone considered.

CHAPTER XIV

PHOSPHATES

Geology—Reserves—Present Developments—Future Prospects.

Phosphorous is essential to the growth of plants and animals. Plants take phosphates from the soils and store up the phosphorous compounds, especially in the fruits and seeds. Animals eat this vegetable matter, assimilate the phosphorous compounds, and deposit them in the bones, brain and nerve tissues. Bones alone contain 80% of calcium phosphate, and solely for the reason that the mineral element was detected in the brain, a phosphorous containing remedy was extravagantly advertised, some years ago, as an efficient mental stimulator.

The constant removal of phosphates by plants soon exhausts the soil in an ordinary agricultural state only replenished by the decay of current floral and faunal life. However, in Wyoming one rock horizon is largely composed of the hardened phosphatic remains of marine animal life that thrived locally for a million years on a scale so vast that modern biology can offer no conceivable comparison.

Wyoming has already seen the birth and death of one phosphate industry wholly of contemporaneous origin. The almost complete extermination of the great buffalo herds in the decade that followed the Civil War littered former pastures with their skeletons. As soon as the railroad came the shipment of buffalo bones provided a traffic income of primary importance. But regardless of the enormous numbers slaughtered, a surprisingly few years sufficed to extinguish the source of supply for one of the original industries of Wyoming.

The task that now confronts Wyoming is to exploit the immensely more valuable bio-chemical rock formations that

underlie millions of acres within the State. In the following paragraphs the magnitude of the problem is briefly outlined.

Geology

In Wyoming all phosphate deposits occur in the Embar or Phosphoria formation of the Carboniferous series. The formation is a mixed dolomitic gray fossiliferous limestone and shale further characterized by the phosphate beds, oil sands, calcerous shales and nodular cherts that it contains.

Recently, the Embar has become one of the most promising black-oil producers of the State. The phosphate beds offer supplemental evidence on the magnitude of organic life entombed therein. In Lincoln, Teton, Sublette, Fremont and Hot Springs Counties approximately 2,500,000 acres of this formation and equivalents contain phosphate beds of workable breadths.

In the past the United States Geological Survey conducted exhaustive studies of the vast phosphate beds of Wyoming. Herein, it is impossible to summarize the extensive literature already accumulated on the subject. For descriptions of vetrical rock seams, 6 feet in width, that contain no less than 84% of the tri-calcium phosphate and which are located either on or near the rights-of-ways of important railway systems, attention is directed to United States Geological Survey Bulletins, Nos. 430, 620, 680 and 764. For a map of all known phosphate deposits of the State, reference should be made to the most recent Bulletin, No. 795, published during the present year.

Colossal Tonnage of Wyoming Phosphate Reserves

According to the latest revisals, published last year in Professional Paper No. 152, the Survey recorded the total reserves of phosphate rock in Wyoming at 115,754,000 tons. That stupendous figure is exceeded by four states, but as phosphates are the most widely distributed mineral fertilizers in America, Wyoming can afford to remain content in occupying the first place in known potash and nitrogen reserves, by far the most costly fertilizers consumed by the agricultural industry of the world. As a matter of fact, the Wyoming phosphates are of sufficient magnitude to meet

national requirements for many decades to come. Lying nearest to the greatest agricultural empire of America and being situated in a state that contains the largest fuel reserves and the most complete diversity of mineral fertilizers known, it is evident that the far more favorably located reserves of Wyoming should soon become the most valuable of all western phosphates.

Present Developments

For the past several years the production of phosphate in the Cokeville district has averaged 7,500 tons annually. This raw rock was shipped to California for the object of restoring the fertility of the citrus-fruit soils of that state. In recent years the mineral content of those costly soils has been appreciably depleted, and largely for that reason, an increasing market can be expected on the west coast for Wyoming phosphates. However, instead of shipping finished products, only the raw and insoluble rock was sent to California for composting with sulphur and other crude chemicals that cause soil bacteria and other oxidizing agencies to break down the Wyoming phosphate into the soluble acid form assimilated by plant life. According to figures of the Federal Survey, only an average price of $4.48 per ton was received for the raw phosphate rock of Wyoming in a recent year. Had this rock been converted into nitrophoska or ammonium phosphate, here in Wyoming, a price ten to fifteen times as great would have been received; and at the same time, high grade technical employment would have been provided for many residents of the State.

Wyoming Has All Raw Materials and Power Potentials Consumed by Latest Manufacturing Processes.

The whole fertilizer problem is interwoven with the production of nitrates and the various processes of catalysis; with acid and non-acid phosphate; with powdered and with liquid fertilizers; with super and double-super phosphates; and with volatilization methods for the utilization of low-grade raw material.

According to *Dr. Payne, in the volatilization process, phosphoric acid results from the ignition of phosphate rock,

*Undeveloped Mineral Resources of the South.

common sand and coke. The white fumes of phosphorous pentoxide combine with the moisture of the air and are precipitated as phosphoric acid.

In United States Geologial Survey Professional Paper, No. 152, the new and revolutionary electric-furnace process of the Federal Phosphate Company of Anniston, Alabama, is described. In that process a charge of raw phosphate rock is mixed with coke and relative pure quartz sand is placed between and around the principal electrodes of an electric furnace. Sufficient air is admitted to the furnace to burn the liberated phosphorous to phosphorous pentoxide. Batteries of these furnaces are operated together, and the resulting fumes pass through cooling batteries to Cottrell precipitators. When the fumes are cooled to a certain temperature they absorb moisture from the air, so that the product is recovered from the galleries and from the precipitators as a highly pure liquid phosphoric acid. The acid is, however, carried through an additional refining process and is marketed in tanks and barrels or manufactured at the plant into a number of commercial salts, including ammonium phosphate which is mixed with potash to form a complete and concentrated fertilizer.

In one valley of Wyoming all five chemical elements that enter into the new and complete fertilizer product exist in exhaustless quantities. In no other state or nation do all of these chemical elements occur on scales so colossal and complete. Awaiting development in the unique and fabulously rich valley is hydro-electrical energy of sufficient potentiality to manufacture all mineral fertilizer requirements of the nation directly from the complete chemical reserves contained in the single valley, aforesaid. Some day more than one of the giant chemical companies of America will sadly regret the failure of their technical staffs to conduct investigations of the unusual resources now visibly consolidated within the completely self-contained, mineral and industrial, empire of Wyoming. In course of time some billion dollar aggregation of capital will find it far more expedient to chemically combine phosphate, potash and nitrogen salts directly in a single Wyoming locality rather

than to import the several raw materials from regions as distant and widely separated as Germany and Chile.

OTHER PHOSPHOROUS PRODUCTS

Pending completion of proposed hydro-electric developments, a number of non-fertilizing phosphatic products could be most economically manufactured directly within the Green River valley. In the electro-thermal process used at present at Niagara Falls the element phosphorus is set free by mixing distantly transported phosphate rock with sand and carbon in the electric furnace. At a high temperature the phosphorous pentoxide is reduced to elemental form and after a simple purification process it is thereupon sold direct to the trade. At the present time most of the elemental phosphorous is consumed by the therapeutical, metallurgical, warfare and other industries in which it makes its final appearance in forms as divergent as osteomalacial medicines, poison gases, safety matches, phosphor bronzes and smoke-screens. In modern aerial and naval warfare maneuvers, electro-thermal manufactured calcium phosphide forms on ignition the dense white smoke-screens used to conceal the movement of troops on land, as well as battleship fleets at sea. If the War or Navy Departments should deem it expedient to set up a plant for the manufacture of modern warfare products, not at a hydro-electrical development on the international boundary but at a central point most invulnerable to foreign attack, it is certain that the safely situated phosphate beds of Wyoming will be able to supply all of the phosphide, phosphine, phosgene, toxiferous and camouflaging agents of a gaseous constituency that the nation may ever require for its own defense. Moreover, from the enormously thick coal seams geologically overlying the phosphate horizons, modern technology can at last manufacture the nation's entire requirements of explosives at the lowest possible costs. In the future, Wyoming raw ingredients for the manufacture of explosives may carry more esteem than the extremely distant and precariously situated natural nitrate deposits of Chile that so

far served to make the powder that America consumed in all wars fought within the past 100 year period.

FERRO-PHOSPHOROUS

Another phosphorous compound for which a greatly increasing demand is arising is the metallic alloy, ferro-phosphorous. At the present time this alloy is chiefly being supplied from the Alabama-Tennessee region. In the electric furnaces of the Federal Phosphorous Company's plant at Anniston, the United States Geological Survey lately reported the manufacture of ferro-phosphorous by adding iron trimmings to a charge containing raw phosphate rock and common reducing and slagging agents. As usual, considerable electro-thermal energy is consumed by the latest technological process protected by rigid patent rights.

Ferro-phosphorous is an alloy exclusively consumed in the modern iron industry. Pending the completion of local hydro-electrical proposals the manufacture of this high cost alloy, selling from $90.00 to $125.00 per ton, will, likewise, be feasible in Wyoming. Therefore, in a book of this kind, it is entitled to mention with ferro-titanium, ferro-chrome, ferro-vanadium and other iron alloys that will be manufactured from Wyoming mineral deposits in the future. As Wyoming has long been the most important producer of iron ore west of the Mississippi River, it is certain that her large reserves of ores of the costly alloy metals will finally do their share in attracting a modern steel industry to the State.

CHAPTER XV

POTASH

Utilization—Leucite Hills Deposits—Extraction Processes—By-Products.

UTILIZATION

Potassium like phosphorous is essential to the life of the plants and animals. In the ash of many grains, vegetables and fruits, its presence is detected in the form of potassium carbonate. Obviously, potassium salts taken from the soil by plants must be returned if the original productivity of the land is to be retained. For instance, an acre of land growing 25 bushels of wheat loses 80 pounds of potash, phosphoric acid and nitrogen, of which 21 pounds is potash. Thus we export 25,000 tons of potash in the form of wheat from the United States annually. Incidentally, most all of these constantly recurring potash losses had to be originally purchased from a single foreign source of supply at an excessive cost.

Heretofore, the United States and the balance of the world have largely relied upon the soluble kainite deposits of the former German Empire for most of the potash salts supplied to their agricultural lands. Occurring in a single region the production and control of potash has always been in the hands of an exorbitant foreign monopoly. Under arrangements long ago perfected potash readily commanded a price much in excess of the foreign cost of production. Therefore, any Wyoming enterprise that will endeavor to break the strangle-hold that an iron-clad foreign monopoly has long exercised over a mineral product so vitally important to the welfare of the American people is entitled to all possible support that can be rendered by the extremely favored citizens of the State.

Non-Fertilizing Uses

In the manufacture of well known chemicals, metallurgical solvents as well as of the better grades of soap, glass, matches and less powerful explosives, great quantities of potash are annually consumed. Not until the cutting off of potash importations during the entire four-year period of the World War did Americans fully realize the importance of a domestic supply. But even ten years before the occurrence of the recent extremely acute situation, a statistician from Boston, Edward Atkinson, filed the following well-chosen remarks:

> "The man who finds a potash mine corresponding to the Stassfurt deposits of Germany will add more to the resources of this country than by the discovery of gold, silver, copper or iron."

In reply to the foregoing prophecy, the fabulously rich Green River valley of Wyoming offers its Leucite Hills as the most promising potash supply for the future requirements of America. In the following remarks the location, geology, composition, tonnage reserves, as well as the latest technological advancements that will probably be used for the extraction of these refractory deposits are all briefly summarized:

Leucite Hills Deposits

One of the largest potash deposits remaining unexploited in the world is that of the Leucite Hills situated directly north of the cities of Rock Springs and Superior. These hills are volcanic necks and knobs that outcrop at 22 separate localities within an area of 350 square miles. Locally, the more prominent hills are called Pilot Butte, Boar's Tusk, Zirkel Mesa and Steamboat Mountain. For those that outcrop in a less spectacular and bizarre manner other emblematical names are likewise given. The area of these different hills range from 10 to 4,000 acres. At their nearest approach these richly laden potash hills are located within two miles of existing railway transportation provided by the Union Pacific trans-continental system.

Tonnage Reserves

Mineralogically, the Leucite Hills are basaltic lava flows of the Tertiary age characterized by the remarkably high

percentage of leucite and other fine-grained potash-rich silicate minerals that they contain. In composition, the total lava flows of the district average no less than 10% in potash, and also, 10% in aluminum oxide. As such, their potash content is appraised by the United States Geological Survey as higher than that of any igneous rock known. According to estimates completed by the Survey, the total potash content and the total aluminum oxide content of the Leucite Hills is each recorded at 197,349,617 tons.

In no other state do known potash reserves approach the magnitude and richness recorded for the Leucite Hills deposits. As a matter of fact in only two other localities within the United States do leucite rocks occur. In either instance their potash content is so low that it is hopeless for commercial exploitation. In size and in quality the potash deposits of the Leucite Hills are wholly in a class by themselves.

Extraction

Unlike German deposits, the potash of the leucite lavas naturally occurs in the insoluble silicate form. To break down the refractory silicate in the soluble form that potash is assimilated by plant life generally requires the use of a high temperature process. When potash silicates are ignited with lime, potash is liberated. Due to this reaction increasing recoveries of potash as a by-product have been obtained from major industrial activities in which ores, fuels, and calcereous slags and clinkers containing minute amounts of potash are subjected to prodigiously high temperature operations. The average blast furnace charge producing pig iron from domestic ores and lime fluxes will yield about 12 pounds of potash per ton of pig iron. Moreover, about three pounds of potash is recoverable on an average per barrel of cement by the Cottrell electrical precipitation apparatus. Many plants, however, do not have sufficient potash in the raw mix to make this recovery possible. Nevertheless, during the stress of the World War no less than 12,652 tons of potash salts were recovered in one year from this rather unpromising source of supply.

By-Product Processes

For making Portland cement it would indeed be hard to conceive of a more ideal lime-shale mix than (3) parts nearly chemical pure limestone of Wyoming, and (1) part leucite, a rock-shale, closely approximating the highly expedient formula of potassium aluminum silicate. In Wyoming both of these raw ingredients occur in exhaustless tonnages. If properly calcined, volatilized and electrically precipitated, the infant cement industry of Wyoming should obtain a potash yield five times as great as the average American recovery. All of this by-product yield would be extra profit alone obtainable from Wyoming rock. In a major industry already known for over-production and sharp competition evils such a side-line income would prove to be a profoundly important, economc advantage.

Direct Processes

Of more interest than by-product operating processes is the complete recovery of potash directly from the leucite rock. For this recovery more than 100 different processes have been patented during recent years. Under the Cowles patent, leucite and phosphate rock are heated together to the sintering point, and among the products obtained are free phosphoric acid and a soluble potash salt. Under the Gardner patent ground leucite and phosphate rock are mixed with alunite and ammonium sulphate and heated to a low temperature to obtain the valuable double fertilizer salts of modern commerce. So far as known neither one of these processes have been exploited on a commercial scale. As a rule the raw ingredients for the furnace charges occur at too great distances from each other for profitable manufacture of the fertilizer compounds ordinarily imported into this country. Should any one attempt to exploit either one of the above patents, the location of a large plant in the Green River valley would be absolutely imperative. Only in that valley do both phosphate and potash deposits occur in literally limitless tonnages. Moreover, for the ammonical and alum salts required by the second patent, reliance could be placed on the huge tschermigite deposits at Wamsutter that are described later in this review. Containing exhaustless

quantities of every raw chemical as well as every form of fuel that enter into the manufacture of all final products sold by the fertilizer industry, it is manifest that the Green River valley offers the only logical location for the practical solution of the more advanced technological accouplements of the day.

Italian Leucite Process

The recovery of potash and other important values from leucite no longer remains a theory of the research chemist. In the past the Italian volcano, Rocca Monfina, emitted lava flows of composition identical to the 10% potash content of the Leucite Hill deposits. The following extract taken from the Survey publication, "Mineral Resources of the United States, 1923," describes the process by which the Italians have been able to exploit their leucite deposits on a scale that has greatly expanded in subsequent years:

"Baron Blanc, who has worked for some time on the problem of utilization of leucite, has devised a simple method of electro-magnetic separation by which the leucite may readily be separated from its gangue. For chemical treatment the leucite is crushed to grains about one-sixteenth of an inch in diameter. Material finer than this is not suitable for acid treatment because of the propensity of the silica contained in the leucite to gelatinize. It may, however, be used for direct application to the soil. Without going into the chemical discussions given in the article it may be stated that by using the granular leucite and circulating dilute acids the difficulty of gelatinization is overcome. Alum may be made directly from leucite by the use of sulphuric acid. The silica that remains may serve at once for the formation of valuable silicon compounds, such as sodium silicate. The treatment of leucite with hydrochloric acid involves greater difficulties in chemical engineering than the treatment with sulphuric acid, but potassium chloride with a purity of 98 to 99 per cent may be obtained, together with aluminum chloride. The aluminum chloride may be converted into hydrated oxide of aluminum and the hydrochloric acid driven off and be used again in attacking fresh leucite.

"The leucite lavas that are being worked at the present time are at Fontanaradina, about 12 miles from the little port of Scauri. The rock, after a very shallow layer of soil is removed, can be quarried at once and by a simple telpherage system can be carried straight down over the intervening country to the wharf at Scauri by gravity.

"The outcome of this experimental work with Italian lavas will be watched with interest because of its bearing on the possible future development of the somewhat similar lavas that constitute the Leucite

Hills of Wyoming, which may be regarded as a potential source of potash and alumina compounds."

By-Product Recoveries of Alumina and Silica-Gel

In addition to potash the complete process of the Italians also extracts the freed alumina and silica values of the leucite. The former oxide is almost a chemical pure ore from which the metal aluminum and valuable alum salts can be prepared. So far, America has never produced sufficient aluminum ore for its requirements.

As noted, the silica is freed in gelatinous form. The mineral, silica gel, has also passed out of the development stage and its commercial value has just recently been demonstrated. Additional uses are continually arising for the newly manufactured product, and by its sale to refrigerating and refining industries one of the larger chemical companies reported an extra profit in excess of one million dollars from new operations conducted during the year of 1927.

In course of time, the Italian process that recovers all of the values from the leucite will likely be tried out in the Rock Springs area. For the separation of the worthless ferrous gangue from the rich potash aluminum silicates, an electro-magnetic process is used. For the reduction of the alumina to the metallic form a large quantity of low-cost hydro-electrical energy is also essential. Upon completion of the hydro-electrical plant recently proposed on Green River, an abundance of energy will finally be provided for the practical and complete development of the refractory potash deposits of the local valley.

For reasons hereinbefore outlined no mineral reserve of Wyoming offers more promise for development than the potash deposits of the Leucite Hills. The recent ability of the Italians to exploit their leucite lavas successfully has caused much attention to be directed to the similar rich deposits of Wyoming. During the present year further interest was stimulated in the Wyoming deposits by the passage of the Winter Potash Bill in the lower house of Congress. Due to these latest technological and legislative advances this office has been in receipt of many rumors to the effect that large financial interests will soon take over the

leucite deposits for practical exploitation. If production can reach natural requirements, Wyoming will enter a stage of industrial expansion scarcely less revolutionary than that accomplished through the development of the large oil pools discovered within her boundaries during the past 15-year period.

CHAPTER XVI

NITROGEN

Natural Ammonia Deposits—Tschermigite—Synthetic Ammonia—Calcium Cyanamid.

In addition to phosphorous and potash, nitrogeneous compounds form the third and remaining group of mineral fertilizers of primary commercial importance that are consumed by organic life. All flesh contains nitrogen and while we live in an atmosphere that envelopes each square mile of the terrestrial surface with 20 million tons of nitrogen, it so happens that neither plant nor animal life can consume this limitless supply in the available elemental form. For assimilation the nitrogen needed for life must be present in the form of a chemically combined salt. As plants take up nitrogen in the form of nitrates or ammonia, it is evident that the soil must be constantly replenished with these minerals if its original fertility is to be maintained.

At the opening of the present century, civilization was greatly alarmed over the pending exhaustion of the world's entire supply of nitrogen salts. At that time the deposits of northern Chile were the only known supply. Accordingly, in his presidential address delivered before the British Association of Science, Sir William Crookes, the eminent physicist and chemist and inventor of the vacuum tube of the now omnipresent radio set gloomily calculated the early day when all reserves of natural nitrates would be completely exhausted. Since that often cited address was delivered 30 years ago, science has made such brilliant progress that the world is no longer dependent on the Chilean monopoly for its vital nitrate requirements. Today, all of the nitrogenous compounds that at least America will require for many centuries to come can be far more cheaply obtained from the remarkably complete chemical and fuel resources that occur

in the Green River valley of Wyoming. In ensuing remarks deposits of nitrogenous salts, as well as all raw materials now used in the manufacture of synthetical nitrogen compounds are described.

Non-Agricultural Uses

Not all of the nitrate production is consumed by reactions that are continually at work within the realm of biochemistry. The vast amount of energy that nitrogen compounds release is also utilized in the basic manufacture of nearly every type of explosive agent known. In bulletin No. 666, the Geological Survey summarized the importations of sodium nitrate consumed in the United States during the year of 1916, as follows:

Uses	Quantity Tons	Percentage
Explosives	600,000	45
Fertilizers	280,000	20
Sulphuric Acid Manufacture	85,000	5
Miscellaneous	400,000	30
Total	1,365,000	100

The vital necessity of a domestic nitrate supply was recognized as early as 1916, when Congress first appropriated $20,000,000.00 to have an investigation made of the best, cheapest and most available means—"for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers." Later, when war was declared, a total sum of $150,000,000.00 was expended on huge hydro-electrical developments along the Tennessee and Ohio Rivers solely for the object of making artificial nitrates by the now archaic arc process. Before those costly engineering structures were completed the war had ended, and for various reasons no nitrates were ever yielded from those colossal investments of the Government. One reason for suspending operations was that the designed arc process consumes too much costly power. By the latest Haber ammonia process, unlimited quantities of nitrates could be produced from the cheap coals of the Green River valley for

one-fifth the cost of production at the expensive water power completions of the Government.

Already, many savants and economists have reason to believe that the war-time nitrate plants of the Government were illy located. Hydro-electrical developments of similar magnitude has already been proposed on the channel of the Green River, and even if the direct arc process had not been superseded by later patents that consume far less power, the local valley happens to be the only single site in the world in which is consolidated huge deposits of every major chemical element consumed in the manufacture of explosive agents. The accessibilities of its limitless deposits of rock phosphates and potash for the manufacture of munitions of war have already been described. Ensuing paragraphs will take up a description of a huge deposit of soluble ammonia mineral. By itself, this deposit will obviate the costly, high temperature, high pressure, synthetic process now used for generating ammonia in modern nitrate plants. Not locating their original nitrate works in regions that contained valuable chemical compounds used in the explosive industry, it is no wonder that costly investments of the Government were never utilized. Manifestly, if one of those huge plants had been strategically located directly within the giant chemical laboratory that naturally forms the Green River valley as a whole, its operation would never suffer suspension as long as the manufacture of explosives was vital for the defense of the nation.

TSCHERMIGITE

At a point four miles southwest of Wamsutter and within one mile of the main line of the Union Pacific railway is a huge deposit of the exceedingly rare mineral tschermigite. Locally, the tschermigite impregnates an uniform seam of lignitic coal 8 feet 2 inches in width, for a distance of nine miles.

So far no governmental agency has filed a report on the recent discovery, but according to a private geological report that a large corporation lately loaned to this office, extensive sampling operations have disclosed the tschermigite content

of the unusual seam of chemical coal to average 2.31 per cent. Careful calculations appearing therein indicate the tschermigite content of the local deposit to equal slightly more than 2,500,000 tons. At present prices its recoverable value would closely approximate $225,000,000.00. Outside of Chile, this office knows of no natural deposit of workable nitrogen compounds that approaches the magnitude of the tschermigite discovery recently made within the Green River valley.

A typical analysis of the Wamsutter tschermigite follows below:

Al^2O^3	11.57%
$(NH^4)\ ^2O$	5.23%
Na^2O	.21%
MgO	.13%
SO^3	35.11%
H^2O	47.82%
Insol	.06%
K^2O, Fe^2O^3, CaO, Cl	Trace
Total	100.13%

As recorded, the above analysis yields the chemical formula $(NH^4)^2SO^4$, $Al^2\ (SO^4)^3+24H^2O$, which is the normal formula for tschermigite, a soluble ammonia alum, that heretofore has only been found most sparingly in the Bohemian region of the former Austrian Empire.

Recovery

Occurring as an easily soluble salt, the cheapest method to extract the tschermigite from the lignite coal would appear to be a simple lixiviation process. Unfortunately, the deposit occurs in a region in which water is so scarce that it is probable that a distillation or even combustion process will be evolved to extract both the ammonia and alum salts at the lowest practical costs. Should a fuel briquet or low temperature carbonization works be set up, the possible recoveries in ammonium and aluminum sulphate should approximate a total value of $2.30 for each ton of the chemical coal so processed. Moreover, a crude and incomplete

of the German Dye Trust (I-G Farbenindustrie) near Frankfort, where nitrogen is literally taken from the air and used to manufacture fertilizers, is one of the most impressive sights in the world. At Hopewell, Virginia, the Allied Chemical Company is now constructing a huge nitrogen plant at a cost of $125,000,000.00. This plant will be the largest chemical operation ever put into effect in this country. On completion America, too, may finally be free from the dangers and vicissitudes connected with foreign nitrate domination.

The Haber synthetical process simply consists in passing a pure mixture of nitrogen from the air and hydrogen obtained from water over a catalyst consisting of iron and certain added impurities, called promoters, at excessively high temperatures and pressures. Nitrogen as it exists in the air is inert and useless, but as soon as it is made to combine with hydrogen or other chemical element it becomes the invaluable and extremely powerful compound that forms the base of dynamite, as well as all other explosives commonly known to commerce and warfare.

The chemistry of the synthetic ammonia process is of the simplest order conceivable. The physics or dynamics of the operation are, however, far more difficult, and as such, are only capable of solution by direct application of the most technical advancements recently made in the metallurgical science. In the first place, to obtain the hydrogen necessary for the direct reaction, water must be decomposed either by electrolysis or else by passing it over hot coke as is done in the manufacture of artificial gas. Either one of those operations must naturally consume tremendous volumes of energies, and when finally isolated, the freed hydrogen will not unite with the inert nitrogen of the atmosphere without the consumption of forces equivalent to those exhibited when those compounded gases are suddenly disunited as happens when their gunpowder molecular combinations are commonly exploded. In the Haber process, the enormous energies required to form the synthesis is expended in immense steel forgings in which are produced the tremendously high pressures and temperatures that finally force the molecules of inert nitrogen

and hydrogen to unite into the most valuable and most powerful, vitally indispensable, basic, chemical combination so far mechanically created by the human race.

In the great nitrogen plants of the world the only raw materials consumed are air, water and inferior grades of coals. Of these common requisites coal alone costs money. Due to the colossal energy consumed, latest available figures indicate that no less than 11 tons of coal are required for the manufacture of one ton of the cheaper nitrogeneous compounds. Obviously, for the future location of $100,000,000.00 governmental or private nitrate plants, fuel supply instead of local water power must receive sole consideration. With minor exceptions every square foot of the completely self-contained potash, phosphate, nitrate valley of Wyoming is successfully floored with a most remarkable series of coal seams. At Conroy on the extreme western rim of the valley an 84 foot seam of coal, the thickest layer in Wyoming, outcrops directly on the surface. At Wamsutter on the extreme eastern boundary of the valley, an 8 foot 2 inch seam of coal outcrops that is literally saturated, not with synthetic ammonia, but with already, naturally prepared, water soluble, ammoniated alums. Morever, at the more centrally situated third railway station of Point-of-Rocks, horizontal blanket seams of coal, as high as 22 feet in thickness, underlie wide areas at no greater depths than 30 feet below the soil surfaces. At the latter site, the colossal tonnages of coal consumed by the latest Haber-Bosch modifications could be mined with modern steam shovel stripping operations at one-fifth the cost of ordinary underground coal-mining operations. Under such unusual economic conditions, the total raw materials costs of national nitrate production at Point-of-Rocks would probably equal 20% of the costs at the private plant now being constructed in Virginia, and not more than 2% of the cost that would occur if nitrogen manufacture was ever attempted at the Government plant feverishly constructed during the war at a far famed point in Alabama.

Dynamically speaking, the cost of manufacturing chemical molecules in million ton lots as powerful and explosive as nitrogen compounds must necessarily remain ex-

ceedingly costly if nothing more advantageous than ordinary coal is to be tried out in the process. The known coal reserves of the Wyoming sector of the Green River valley are exceeded by no single state. Among the most remarkable of the local varieties is the tschermigite seam at Wamsutter. In addition to containing the colossal energies required to synthesize nitrogen and hydrogen, that wonder seam also contains a content of already prepared powerful ammonium salts hereinbefore evaluated at $225,000,000.00. Obviously, for cutting down overhead expenses, and also, for avoiding the terrific consumption of power required for artificial synthesis, no chemical or fuel deposit so far discovered in the United States possesses the promise and potentialities of the Wamsutter coal seam.

Wyoming Mineral Deposits Merit Investigation

In the premier mineral royalty paying State of Wyoming the activities and missions of certain scientific bureaus of the Government are no longer fully understood. Excluding the Caliche beds of Chile, no single mineral deposit is known to contain a nitrogen chemical content of the magnitude found in a single Wyoming coal seam. Until the true character of the vast chemical forces contained in these coals can be fully ascertained by actual study and experimentation, technological anachronisms as hopeless and complete as the $150,000,000.00 financial fiasco at Muscle Shoals may again be expected to receive the official approval of scientists in the employ of the Government.

In the past eight years the single State of Wyoming surrendered directly to the Federal Treasury a sum of over $47,000,000.00 in mineral royalty payments alone. That figure happens to exceed by two and one-half times all monies similarly collected from the remaining 47 sovereign states of the Union. Until a dollar or two of the Wyoming colossal receipts can be legally expended in booming the unparagoned mineral deposits of the State, the mineral industry of Wyoming will not rest from evil nor see the light of day. While other great nations of the world have already refused to suffer foreign domination for their supplies of nitrogen, in reality the foundation of their food supplies, the Great Republic has remained content to adopt a

far more facile and easy-going program. As developments now stand, this office refuses to predict how much nitrogen will ever be yielded either from the $125,000,000 now being expended on the exploitation of common, non-chemical, eastern coal deposits, or from the $150,000,000.00 investment that the Government recently expended in hydro-electrolizing the Tennessee and Ohio River channels primarily for the object of making powder during the late war.

CALCIUM CYANAMID

For several years past, international banking groups of America have been feverishly engaged in financing fabulously profitable nitrogen operations for the manufacture of fertilizers and cannon powders, not in the United States but at outside points as widely separated as Norway and Chile, and, Berlin and Tokyo. One extremely prosperous domestic corporation known as the American Cyanamid Company, however, is already making their own line of nitrogenous products. But strange to relate, instead of locating their plant in the United States, the Canadian side of Niagara Falls had to be selected as the logical site for the domestic exercise of their invaluable patent monopolies.

To make cyanamid, all that is necessary to have is air and water, limestone and coal, and lots of power. All of these lowly raw materials and forces appear in great abundance in the lower Green River basin, and incidentally, in many other far less favored localities. However, to cause these most common substances to unite into the extremely powerful cyanamid radicle calls for a modern technical operation that would be folly to attempt in any locality less chemically remarkable than the Green River valley. In only that favored valley do two of the chemical elements of the molecule occur already combined; and due to that union, the future production cost of cyanamid to the American agriculturist will be cut in two by operations that nature long ago fortuitously performed gratuitously only in Wyoming.

For cyanamid manufacture, two simple chemical compounds, calcium carbide and ammonia need alone be pro-

duced. The carbide results from the union of the limestone and coal, and ammonia is ordinarily made from the nitrogen of the air and hydrogen from water. As soon as these two powerful compounds are brought together, calcium cyanamid, the original of artificial nitrogen fertilizers, and also, a salt that has lately found much use in the chemical industry is readily produced.

Naturally, compounds as powerful as the cyanamids consume a tremendous amount of energy in their formation. The recent conquest of science in finally producing synthetic ammonia has already been reviewed herein. For the formation of the carbides that are now utilized in many common industrial operations, the expenditure of considerably less energy is required. For their manufacture a common lime and carbon charge is placed in an electric furnace and at a temperature approximating 2,000° the carbide compound used in old-style miner's lamps and superseded automobile lighting systems is effected.

For the economic operation of electric furnaces, low cost waterpower has heretofore been deemed essential. In recent years the more virile statesmen of Wyoming have insisted upon the early completion of a 71,000 continuous horse power hydro-electrical development at a single site on the lower Green River valley. In more ways than one, their tireless labors are entitled to the appreciation of the residents of the valley. The proposed development is of ample potentiality to manufacture carbide from local coals and limestones on a national scale of production. But that is not all. As soon as the water soluble ammonia of the Wamsutter coals would be pumped into the manufactured carbides, nothing short of calcium cyanamid would be the end result of the local modus operandi. Manifestly, such a procedure would produce an industrial transposition that would vastly strengthen the economic independence of not only Wyoming, but also, the nation at large.

Against the natural chemical laboratory formed by the Green River valley, it would be hopeless for the pioneer, Niagara Falls, foreign contender to remain longer in the battle. Obviously, to put a sudden quietus to the incongruity of America making all of her cyanamid on the Cana-

dian shore line of the Niagara River, nothing would prove more disastrous than a sizable hydro-electrical completion directly within the heart of the Green River valley. Obviously, until such engineering completions materialize in Wyoming, the long suffering corn and cotton planters of America will be in no position to join a buy-it-at-home movement of visible sincerity. For early solution of thoroughly needless foreign domination over a basic chemical product the State of Wyoming should never falter to call loudly to the constructive statesmanship of the West. Obviously, vastly important domestic mineral deposits will continue to remain ignored until the might and mettle of the best statesmen of Wyoming are tested to the limit.

Co-operative Aid Acknowledged

One hard working resident of the valley has made it a point to keep up to date on all of the latest highly technical modifications that almost daily transpire within the world-wide nitrogen industry. During the past year said philanthropically inclined correspondent donated a number of copies of an European scientific journal to this office. In one of them the latest cyanamid molecule recently evolved in Germany was described. This new patented product seems to be possessed with a most uncanny degree of selectivity. Its great value is not confined alone to its properties as an effective fertilizer, but also to the fact that it destroys weeds, as well as kills all kinds of vermin that injure growing crops. The new fertilizer, known as the Frank Caro process, actually fulfills a dual purpose. Its extraordinary effect on a weed patch was strikingly illustrated by a photograph that accompanied the text. As illustrated, alternate rows were ploughed and only those that received the deadly cyanamid treatment were the weeds entirely supplanted by exceedingly healthy growths of the more delicate vegetable strains commonly raised by agricultural endeavors.

Many observations of the style and character selected for this expose have naturally produced visible effects on schools of thought located both in this country and abroad. For instance, no less an authority than Professor Shimer

of the Massachusetts Institute of Technology is recently quoted with the observation following below:

> "Man has passed through the stone age, the bronze age and the iron age and is now in the nitrogen age."

If the day ever arrives when the element nitrogen will serve as the index of civilization in the U. S. A., then and not until then will the Great State of Wyoming finally command its rightful leadership as the premier chemical, mineral as well as Federal Royalty producing State of the united Forty-eight.

Before constructing the new mill, hundreds of chemical tests were made from drill samples systematically taken throughout the deposit. These tests revealed a true cement-mix approximating 85% in lime composition of an extent sufficient to operate a cement mill of 6,000 barrel daily capacity for a period of more than 250 years.

At the beginnig of the new year, Wyoming will become an important producer of cement for the first time in its history. The first unit completed for the Laramie mill will turn out 2,000 barrels of cement a day. The present plans of the company call for the early completion of the second and third units to their $2,000,000.00 plant. Upon completion of the latter additions, the company's daily operations will more than supply all markets that will arise for cement in Wyoming.

The new cement mill at Laramie is the largest ceramic operation that has so far been completed in Wyoming. In recent years most all of our towns and cities paved the streets in their business districts. In every instance the cement used had to be purchased from distant mills located in outside states. The completion at Laramie will not only stop a severe drain that has too long been made on the financial resources of our State, but more than any other factor, it will stimulate the construction of additional mileages of cement highways and streets directly from materials manufactured in Wyoming at the lowest costs.

PORTLAND CEMENT MATERIALS

Close to many towns and cities of the State are important deposits of nearly pure limestones and shales. Portland cement of the highest quality could be made from these materials at a low cost. In course of time additional cement mills will likely be constructed in Wyoming at points most distant from the Laramie region. The city of Sheridan, as well as the more important towns in the Basin, are some of the points that offer advantageous sites for future mills. In their immediate environment are huge deposits of all raw materials and fuels consumed by the industry.

neighboring states but from now on the new plant at Parco will largely eliminate that serious drain upon the State.

During the present year the Cross Gas Company excavated and mined approximately 5,000 tons of clays and shales for the manufacture of their well known lines of drain and sewer pipes, floor tiles, face bricks, flue linings, and hollow blocks in their modern plant situated at Lovell. The finished wares of this firm are of the highest known standards and largely for that reason the fame and market for their ceramic products broaden widely in each succeeding year.

In their plant natural gas is used exclusively. Without that ideal form of fuel it would be impossible to obtain the sensitive temperature controls demanded for the manufacture of their products of superior merit.

REFRACTORY MATERIALS

As yet no studies or tests have been made of the relative merits of the huge deposits of fire clays, gannisters and lesser known refractory materials that occur in many parts of the State. Due to the variety of deposits, a refractory industry should soon develop in the State. Exploitation of the cheaper and more common materials must naturally await further industrialization and settlement within the State. Beyond making Wyoming a complete industrial empire, the more ordinary refractory deposits may be said to have no value at the present time. In the future the availability of the local deposits should do their full share in attracting steel, hydro-electrical, chemical, fertilizer, metallurgical and other industries that are largely dependent on modern high temperature generation for successful operation.

Among the most valuable refractory minerals found in Wyoming are kyanite, graphite, chromite, titaniferous iron ore, talc, tripoli and some forms of mica. With the exception of kyanite, descriptions of the character and extent of these minerals appear elsewhere in this volume.

Kyanite

The wonderful properties of kyanite as a modern refractory do not appear to have been discovered until the past few years. Accordingly, it has been found out that bricks made of kyanite will withstand two cones of temperature higher than that of any other commercial refractive so far discovered. Its melting temperature of 3,400 degrees Fahrenheit permits the calcined mineral to be used for lining kilns and electric ovens in which the highest temperatures of modern metallurgical practice are produced.

Important discoveries of this rather rare mineral in a relatively high state of purification are frequently reported from both Wheatland and Encampment localities. At present, mineral of similar purity appears to be sold at eastern points from $50.00 to $65.00 per ton after undergoing mining and preparation costs ranging from $15.00 to $20.00 a ton. In event the Wyoming deposits prove to be of commercial extent, plants for the pulverization and calcination of this highly refractory material will certainly be erected in the Wheatland and Encampment localities. But before this office can supply reasonable conclusive information to correspondents on these and similar deposits, constantly reported, the services of one or more research ceramicists would have to be continuously employed first of all. At the present time this department has no funds available to conduct extremely advanced chemical and pyrometrical tests of Wyoming material, the virtues of which so far remain largely undescribed in the latest scientific literature.

Chrome and Titanium

Chrome iron ore is another exceedingly valuable refractory material. In the form of fire-brick, chromite now sells for $45.00 per ton. The United States Geological Survey reports the deposits on Casper Mountain as the fifth largest reserve in the United States. It is possible that these low grade deposits offer more promise for exploitation as a refractory than for direct reduction to the metallic form. Studies along these lines should be conducted in the future.

So far the huge deposits of high grade titaniferous ores at Iron Mountain have not been exploited for the stated

reason that their reduction is not possible by temperatures obtainable in the modern blast furnace. Should some one take the time to conduct tests, their melting point would presumably be found to be on a parity with that of chrome fire bricks. In that event, an incomparable supply of raw material is now available in Wyoming for the establishment of a highly profitable refractory materials industry. At the present time advanced pyrometrical tests of the comparative order described cannot be conducted by the equipment installed in this office.

In quality and magnitude the huge titaniferous deposit at Iron Mountain is in a class by itself. Had a similar deposit occurred elsewhere, it is possible that its economic possibilities would largely be known by this time. As now as in the future, Wyoming must look to itself for the solution of the Iron Mountain problem.

GLASS-MAKING MATERIALS

At two different sites in Wyoming every ingredient that goes into a modern glass furnace charge are found in vast quantities. In addition to pure snow-white quartz sands, these materials include deposits of chemical pure sodium sulphate and limestones as well as the solid or gaseous fuels necessary to fire the glass furnaces aforesaid. These two sites are at or near Laramie and Lovell, Wyoming.

In both of the cities mentioned, glass-works were built in the past. In either case their establishment appeared to be somewhat premature. At the present time the bigger and more successful glass-works of the nation are located at or near large consuming markets. To those points glass-making materials in the crude form can be shipped at far lower freight rates than the exorbitant charges that ordinarily prevail on the bulky containers and other similar fragile products that are shipped from the factories.

For the next ten years or more, Wyoming should be more interested in developing a market for the wonderful deposits of glass-making materials that abound in the State. In a prior chapter the vast deposits of sodium sulphate in Wyoming have been described. At the present time these

deposits remain unprotected by tariff charges. If adequate duties can be provided on this sodium compound the comparatively near deposits of Wyoming would attract more favor with large eastern manufacturers than present sources of supply that reach their plants at the low carriage rates that prevail on goods transported on the high seas.

If adequate duties are provided, more glass-making works would be established in the large centers of population of the Missouri and Mississippi valleys. At such points the exhaustless raw materials of Wyoming could be shipped at the lowest possible charges.

POTTERY MATERIALS

In times past, Chambers of Commerce have reported the existence of feldspar and other deposits suitable for the manufacture of pottery and porcelain products within the immediate vicinity of Wheatland, Casper and other Wyoming cities. As yet no plants have been established for the manufacture of these products in Wyoming. Their establishment is surrounded by transportation, marketing, and other economic problems of the character described under the previous heading. In course of time some of these deposits will be developed, but herein, nothing would be gained by a reiteration of remarks appearing in the chapter immediately preceding.

CHAPTER X

ROAD MATERIALS

Sand and Gravel—Manufactured and Natural Asphalts—Road Oils.

In most of the preceding chapters, Wyoming was generally found to be a giant and complete storehouse for the several types of geologic deposits reviewed. The same conclusions can be filed on the wealth and variety of its road materials. On completion of the new cement mill at Laramie, Wyoming will be among those two or three highly select states that will produce a superabundance of every kind of material used in the construction of modern highways. In addition to ordinary binding and surfacing materials, the remaining products include bricks, cements, road oils, as well as both natural and manufactured asphalts. In the following remarks space will only permit mention of products now being exploited in a vigorous manner, and of products not described under other chapter headings of this book.

SAND AND GRAVEL

Every town and city in the State is either underlain or else situated near deposits of sand and gravel. These deposits are of ample magnitude to take care of any possible expansion that may occur in the structural or building trades on all future occasions.

The great consumer of these lowly materials is the 3,023-mile long Federal Aid highway system started in 1917. At the present time about 200,000 yards of sands, gravels and crushed rocks and shales are annually used for surfacing and binding material on this semi-completed modern road system. Much of this material is taken from pits and quar-

ries situated on or directly adjacent to new road construction.

Every mile of the 1,922 miles of railroad constructed in the State is ballasted with Wyoming material. A total mileage almost as long situated outside of the State is also constructed of the same material. For ballasting their road bed as far east as Omaha the Union Pacific annually excavates many thousands of tons of disintegrated granite from their Sherman Hill borrow pits. For their lines in Utah, gravel is dug from the Irvine pit located at Green River. During the past year $50,000.00 was expended in opening up a new pit in that city that provides an additional shipment of 700 tons daily.

In 1927 the five railways operating in Wyoming reported commercial shipments of 5,060 cars of stone, sands, gravels and clays amounting to no less than 269,372 tons from pits and quarries situated on their lines. No records are available on cars of ballasting material that the railways transported over their own lines free of cost. To maintain their road beds both in and out of Wyoming, their non-reported business doubtlessly exceeded the revenue shipments by several times. Most of their long haul shipments were evidently destined to points outside of the State.

As yet no figures are available on the railroad shipments of 1928. At the beginning of the year the railways voluntarily reduced the rates on sand and gravel shipments. This move highly stimulated the export business of the rapidly expanding industry. Domestic non-revenue shipments of railway ballasting material were also vastly augmented by the Union Pacific in constructing their new 52 mile cut-off from Egbert to Creighton. At the peak of the construction period as high as 70 men were employed in their Sherman Hill gravel pits at Buford. Due to the superiority of local deposits, Wyoming can look for a continued healthy growth in an industry largely financed by federal highway funds as well as by out-of-state sales and shipments. At the present time the increasing payrolls originating from these sources contribute their part in making Wyoming a prosperous state.

ASPHALTS

Manufactured Asphalts

It is not generally known that Wyoming is an important producer of manufactured asphalt. At the present time incomplete statistics indicate that Wyoming ranks ninth among the states in the production of asphalt made wholly from their own sources of petroleum supply. In the East, refineries manufacture large quantities of asphalt solely from oils transported from distant states or else imported from foreign shores. As soon as a larger demand arises for asphalts in the Rocky Mountain area an opportunity will be provided to develop some of the black oil pools of the State from which production has so far been closed.

So far but 36 miles of the state highway system has been paved. In the future long mileages of these roads will be paved with modern asphalt and concrete material, all of which will be made in Wyoming, exclusively.

According to report submitted by the Midwest Refining Company, their shipments and deliveries of asphalt from their Wyoming refineries in 1927 approximated as follows:

Destination	Tons
Rocky Mountain territory (Wyo., Colo., Mont., etc.)	5,600
East of Rocky Mountain territory, except Neb.)	15,500
Nebraska	2,425
Canada	825
Total	24,350

The foregoing figures plainly disclose that before Wyoming can consume the greater portion of her manufactured asphalt production, the population of the state will have to be multiplied at least tenfold. Precisely similar remarks apply to practically all of her mineral products, irrespective of all contrary propaganda current to buy or sell only home-made goods. As a matter of fact, due almost exclusively to our giant oil industry, Wyoming is already one of the big export states of the Union in mineral products.

NATURAL ASPHALTS

The extensive deposits of asphaltic sandstones known to occur in central and southwestern Wyoming would provide first class surfacing material in their raw form. Due to the isolation of these deposits, as well as their inability to compete with the pure asphaltic by-products of our refineries, the natural deposits have so far remained undeveloped. Logically, development of these unusual mineral reserves must await the increased road expansion programs of the future.

Should similar sandstones occur in less favored mineral states, vigorous attempts would be made to liquify or distill off their 10% bituminous or asphaltic contents. In Wyoming no economic reason exists to undertake such superfluous developments. The pure petroleum asphalts turned out by the Midwest Refineries have an intrinsic value at least twice as great as the natural asphalts ordinarily produced in the United States. So long as the big producers continue to manufacture far more asphalt than the State can possibly consume, it would be folly to take further note of the decidedly inferior natural reserves of Wyoming.

ROAD OILS

The progress that oiled highway construction made in Wyoming during the present year was recently summarized in the press. In their issue of October 5, 1928, the Eagle concisely reviewed the economics and technology of the oiled highway operations that have so far been conducted in Wyoming. As their condensed report covers latest findings and developments, it is accordingly inserted below:

Oiled Highways in State Are Proving Success Everywhere

"With completion yesterday of thirty miles more of oiled surface on the state highway (from Casper to Natrona), highway commissioners here for the meeting of the board are viewing with satisfaction the progress made in oiled highway work during the present season.

"At the present time, according to Z. E. Sevinson, superintendent of the state highway department, Wyoming will have ninety-two miles of oiled highway at the end of this year. This construction is

more or less an experiment but which is now regarded as having proven the feasibility of using oil on Wyoming roads.

"At the present time there are 25 miles of oiled highway adjacent to Laramie on the Lincoln Highway, six miles from Rawlins to Parco, thirty miles from Casper to Natrona, two miles from Torrington south, nine miles on the Torrington-Lingle road; and twenty-two miles from the end of the pavement of the Casper-Salt Creek road to Midwest.

"Highway commissioners point to the success of the oiled highways in California and Oregon and to the successful result of the oil construction in Wyoming as evidence of the advisability of stressing this type of highway whenever and wherever conditions warrant.

"Several factors, they say, indicate that the oil highway is to be preferred over other types of construction.

"Wyoming black oil, now wanting a market, has been proven to be on the equal with California oil for this use. The oil when prepared for highway work has an asphalt base of from sixty to seventy per cent.

"Much of the desirability of concrete or asphalt paving, costing between $35,000.00 and $40,000.00 per mile, is also found in the oil surface when laid under similar conditions, costs $1,500.00 a mile, it is pointed out.

"When compared with other surfacing the oiled highways are not costly to keep in repair. The ordinary gravel surfaced road requires $250.00 per mile to maintain in repair each year, a fact which is attributed largely to the wind. It is stated that the gravel surface loses an inch a year, which amounts cost from $700.00 to $1,000.00 a mile to replace. To completely re-surface a graveled road about once every seven years, the cost amounts to from $4,000.00 to $5,000.00 per mile.

"Some oiled roads in California, it is said, are in splendid condition after ten years' use without repair.

"Although the opinion of both highway commissioners and the highway superintendent appear to favor more oiled roads, the extent to which such construction will be undertaken next year is indefinite, however, until the amount of money available for highway construction and the general needs of the State are taken into consideration."

Many residents have already had occasion to strongly endorse the reported findings of the State Highway Department. Next to asphalt and cement pavements, oiled roads are preferred above all other types of highways that can now be constructed wholly of Wyoming materials. By no means is this general approval confined to the residents of Wyoming. In a late issue of a Nebraska paper its readers

were advised to take a trip to Wyoming in order to see what a real road looked like. In this instance specific reference was made to the 9 mile section of oiled highway construction recently laid between Torrington and Lingle.

The time is here for Wyoming to gain leadership in oiled highway construction, not only throughout the entire Rocky Mountain region, but also over wide expanses lying directly adjacent thereto. In the future the State itself should serve as a giant research laboratory for the use and application of its high-grade asphaltic oils as a medium for the practical solution of the rapidly increasing traffic problems of the day. For the next several years it would seem advisable to construct the new oiled roadways over stretches that lie directly within the Wyoming boundaries. Already, this new type of construction has appealed to the fancies of at least one of our neighbors. If all surrounding states would have a similar opportunity to contrast the advantages of oiled highways, it would not be difficult to develop a far broader market for the output of our petroleum fields of high asphaltic base. Since Oregon Basin and later pools have been brought in, it is daily becoming harder to find sizable markets for the black oil production of Wyoming. Any move that the State Highway Department may make to popularize the sale of this Wyoming produced commodity in neighboring states is bound to receive the unanimous endorsement and support of the black-oil producers of Wyoming.

In Wyoming nearly all black oil production is from pools located on public lands that belong either entirely to the State or else jointly to the State and the Federal Government. This unique situation makes Wyoming an actual proprietor of the major oil operations conducted within its vast confines. In every sense of the word this proprietorship calls for added responsibilities on the part of the several departments of the State Government. Therefore, whenever an opportunity is presented for any one Department to promote and enlarge the market field for commodities produced directly under state proprietorship, approved business practice demands that the added role of a commercial salesman be also performed by the administration in charge. If

sufficient missionary work is done along oiled highway construction, in course of time the public royalties collected from added sales and shipments to neighboring states, barren of petroliferous deposits, should prove sufficient to finance more road building programs directly within Wyoming. Manifestly, no tax-payer would file serious objections to neighborly sales promotion campaigns and other self-supporting movements of the procedure hereinbefore outlined.

In the meanwhile, Wyoming should continue to demonstrate the feasibility and economics of oiled highway construction. If that type of roadway is built on locations that extend to the boundaries of the State, our neighbors would occupy the best possible vantage points to make protracted studies and comparisons of its superior merits.

CHAPTER XI

MINERAL PIGMENTS

Carbon Black and Asphaltum Manufactured Products—Rawlins Red and Other Natural Deposits.

CARBON BLACK AND ASPHALT

The most valuable pigment material manufactured in Wyoming is carbon black, made entirely by subjecting natural gas to a process of incomplete combustion. The plants at Lance Creek and Riverton annually produce about 2,000,000 pounds of carbon black, worth approximately $100,000. This output is sufficient to rank Wyoming in fifth place among the carbon black producing states. It may also interest taxpayers to know that every pound of this production is sold entirely outside of the State.

Another material manufactured on a large scale in Wyoming that frequently finds its way in the paint industry is asphaltum. Under the road material section of this report the large amounts of asphaltic sales and exports made by the Midwest refineries in 1927 are fully reviewed.

RAWLINS RED

Formerly much "paint-ore," known as Rawlins Red, was shipped from the hematite mine situated two miles north of the Rawlins depot. Material from this deposit has been used to paint the Brooklyn bridge and other large engineering structures. Active operation of the property ceased many years ago. Last summer, H. Larsen obtained a new lease on the old workings and some shipments have already been reported therefrom.

Private geologists have estimated the Rawlins deposit to contain from 1,000,000 to 1,500,000 tons of ore serviceable for the manufacture of an excellent mineral paint-base.

Analyses disclose that the local deposit contains 93% oxide of iron. Mixed with linseed oil, a dark red paint, remarkably fire-resistant and of phenomenal durability is produced.

If contracts for new public buildings and bridges would specify "Rawlins Red" for paint coatings a wide demand should again be awakened for the most promising natural pigment material in Wyoming. The deposit is easily accessible to rail transportation and for ornamental and preservative purposes the Wyoming product long ago enjoyed an established reputation.

Growing Wyoming, itself, is now of sufficient magnitude to create a strong local demand for the product of the old paint mine. For resumption of former production schedules an initial order from a public agency would aid the present management most materially. As soon as regular deliveries are possible, "Rawlins Red" should once more prove popular for painting private edifices as well as the buildings, bridges, and rolling stock of the Union Pacific and other railways of the State.

OTHER NATURAL PIGMENTS

Other natural pigment materials that occur extensively in Wyoming include bentonite, barytes, graphite, grinding mica, and also chrome and titaniferous iron ores. Detailed geological descriptions on the extent of these deposits appear under the separate discussions that these minerals receive elsewhere in this work.

For making the most valuable paints, our chrome and titaniferous minerals offer the greatest promise. These Wyoming reserves can supply huge tonnages of raw material suitable for the manufacture of a widely diversified line of modern enamels and brilliants. In the Iron-Ore and Hydro-electrical chapters are reviews of the economical and technological problems that await solution before chromium and titanium industries can be successfully established in our State.

CHAPTER XII

MISCELLANEOUS NON-METALLIC MINERALS

Asbestos, Bentonite, Graphite, Gypsum, Limestone, Mica, Mineral Waters, Sulphur and Minor Non-Metallic Deposits.

In the introductory remarks of this section, a scheme of classification was suggested that would list every non-metallic mineral under certain industrial groupings. Therein, it was further stated that each of these separate minerals would be described under the industry that consumed the greater share of its products.

Heretofore, it has been an easy matter to follow the plan of classification devised. From hence on some of the most common minerals of Wyoming, like bentonite, gypsum, and limestone, will each be recorded as having acquired a hundred or more different uses in the widely diversified arts and industries. Manifestly, to list any one of these minerals under any particular industrial division would be extremely difficult, even if figures were available to indicate its relative tonnage consumptions by the different industries.

In order not to accentuate unfairly any individual use of the more mobile or adaptable minerals of Wyoming, the present chapter on "Miscellaneous Non-Metallics" was prepared. In addition to the three minerals mentioned, other non-metallics of slightly less multifold uses, likewise, receive disposition under this loosely assembled miscellany.

ASBESTOS

Asbestos, chiefly of the valuable chrysotile variety, is found in the Casper, Big Horn, Laramie, Wind River, Seminole and Medicine Bow ranges of mountains. As a deposit is also reported in the Black Hills area of Crook County, the

mineral occurs in all of the mountain ranges of the central and eastern portions of the State. This distribution is of far wider extent than in other producing states in which commercial deposits are generally confined to one comparatively small locality.

Wind River Mountain Deposit

Probably the highest grade asbestos so far uncovered in Wyoming is the Wind River deposit recently examined by a representative of this office. At the extreme southeastern tip of the mountain range a serpentine dike, approximately 3,000 feet in length and 400 feet in width, intrudes in an easterly-westerly direction in Sec. 26, T. 30 N., R. 100 W., 6th P. M., at points situated four miles due north of Atlantic City. A tunnel 440 feet in length and other smaller prospect workings have disclosed considerable areas of the dike to be interspersed with small bands or veinlets of cross fiber chrysotile, the most valuable of all asbestiform minerals. At places, fully 15% of the serpentine is composed of silky, greenish yellow fiber varying from one-eighth to more than one-half inch in length. By inspection, the color, silkiness, flexibility and tensile strength of the local fiber appeared to be of the highest order known to the trade.

Fiber of one-half inch and longer is used for spinning purposes. Present prices for this valuable material range from $200 to $650 per ton in New York. The local fiber has already been spun into yarns, ropes and woven into fabrics. Many samples of the finished products were inspected in the Lander offices of A. H. Maxwell, attorney for Chicago interests who recently patented a group of six claims at a favorable location on the mineralized dike.

Casper Mountain Deposits

The largest deposits of asbestos in Wyoming are those on Casper Mountain, generally known as the Casper Mountain and Smith Creek areas. The former is situated eight miles due south of Casper and the latter lies 20 miles southeast of the city.

The Casper Mountain area covers approximately four and one-half square miles in extent. Both areas are composed of serpentine, diorite and granite rocks. The local

variety is chrysotile, and as in the Atlantic City district, it appears exclusively in the serpentine.

No reports on the mentioned areas have been prepared by this office in recent years. In Bulletin No. 470, printed in 1911, the United States Geological Survey published quite a complete description of the local depositions. Therein, the conclusion was reached that the Casper region seems destined to become a factor in the asbestos industry of the United States. Since that time a considerable tonnage has been mined by Fred Patee and associates, but in lieu of attempting any costly manufacturing processes, it appears that all of the asbestos so far recovered has been made into fireproofing and roofing material, for which a local market has developed.

Uses

Asbestos is an important fireproofing material and it is largely from the best chrysotile variety that heat and fire resisting textile products are made. On the other hand, as a common insulating material for pipes and furnaces its use baffles both heat and cold.

Spun and woven into incombustible cloth, it commonly serves for theater curtains, gaskets, automobile brake linings as well as for the fire proof suits, aprons, gloves, leggins and helmets used by firemen and modern welders. Increasingly large quantities of the shorter length fibers are annually consumed by the building trade and automobile industries. New uses in the rapidly expanding fields of mechanical refrigeration, electric insulation, oxyacetylene welding and other strictly modern industries all offer added markets for the product. Such constantly increasing demands promise early development for the Wyoming deposits.

Extent of Exploitation of Canadian Deposits by the American Asbestos Industry.

While the United States is by far the largest manufacturer and consumer of asbestos products, nevertheless, the quantity mined within its boundaries is wholly insignificant. According to latest figures of the Government, in 1927 the producers of the United States sold 2,986 tons of asbestos while the quantity imported during that year amounted to

no less than 223,693 tons. As developments now stand, America is dependent upon foreign minerals for 99% of its asbestos requirements.

For many years past the American asbestos industry has largely been in the control of a single, strongly entrenched corporation. Their raw product is obtained from widely known asbestos properties that are situated in Canada, less than 75 miles north of the Vermont line. As the product from those proven and developed mines are imported into this country free of charge, it suffices to state that comparatively little capital has been expended on the known prospects of Wyoming and other states.

Until some form of protection can be procured, America will probably remain entirely dependent upon the conveniently situated and easily obtained Canadian deposits for the major share of the world's asbestos production it actually consumes. Manifestly, the domestic mining of the important and basic mineral should be encouraged in every possible manner. In event a favorable tariff could be obtained, the development of the widely distributed Wyoming deposits should be considerably accelerated.

A Pioneer Shingle Manufacturer Now Developing Wyoming Asbestos Deposits

During the past year capital was floated for the establishment of an asbestos shingle mill in Casper. The leading party of interest in the enterprise is Fred Patee, who has been a pioneer of asbestos exploration and development in the Casper region for many years past.

For raw materials the new organization will depend upon the extensive deposits of asbestos situated on Casper Mountain, a few miles south of the city. Until the recent activities of Mr. Patee, practically no steps were taken to exploit these unusual deposits in a commercial manner.

One factor that retarded development for so long a period is the shortness of fiber of the Casper deposits. Most all of the local deposits consist of fiber from one-eighth to one-half inch long, or lengths far too short to serve as the extremely valuable spinning fibers of commerce. However, in the past few years the monopoly that long has had com-

plete control of the asbestos industry of America discovered that a most excellent type of shingle could be manufactured from their comparatively worthless short fiber material. The superiority of the new shingle is already conceded, and during the past year the asbestos monopoly conducted a nation-wide advertising campaign that doubtlessly led to vastly increased sales of their modern and costly roofing products.

The new shingles will be made under Patee's own patents exclusively. In the process it is understood that no attempt is made to separate the contained asbestos from the gangue rock. All of the material, as mined, is ground and pulverized into a matrix which is later casted and moulded into shingle squares. As manufactured, the contained fiber acts as a mechanical binder and thereby sufficient additional strength and resiliency is imparted to the thin casting to permit its use as modern shingling material. In doing away with costly hand separations, Patee maintains that he can produce asbestos shingles at a cost approximating 10 per cent of the retail prices now established by his powerful competitors. At the present time Patee also claims ownership of countless thousands of tons of rock suitable for the manufacture of asbestos shingles. As fully ninety-nine per cent of the asbestos products consumed in the United States are of foreign origin, and in view of the many superiorities that have lately been recognized in asbestos shingles as modern roofing material, Mr. Patee and financial conferees now appear to be opening up an exceptionally promising field of industrial activity. As the form of mineral deposits now being exploited is exceedingly rare in the United States, it is believed that the pioneer efforts of Patee and associates will receive the continued support of local financial interests.

BENTONITE

Bentonite, sometimes called medicinal or paper clay, is universally present in the oil districts of the State. It is found in beds ranging from a few inches to over five feet in thickness in the Benton formation of the Cretaceous Age.

Location of Deposits

The following counties are known to have available beds of bentonite: Albany, Big Horn, Converse, Crook, Fremont, Hot Springs, Johnson, Natrona, Park, Sheridan and Weston. Deposits are especially abundant in the Big Horn, Laramie and Newcastle basins. At present the last two localities produce all of the bentonite that has lately been shipped out of the state in gradually increasing quantities.

Bentonite is a light colored colloidal clay of volcanic origin that possesses a high degree of absorptive power for water and other liquids. In Wyoming the outcrops are noticeable for their white powdery appearance which strongly contrast with the otherwise black shales of the Benton formation. When freshly uncovered it appears as a bedded joint clay and due to its softness, it can be mined at a comparatively low expense.

Many New Uses Developing

Bentonite is chiefly used as a bonding agent in molding sands, as an absorbent agent in medicinal and beauty clays as well as in the manufacture of soap, drugs, paper, paints, plasters and many other articles. So far over 100 uses have been discovered for this remarkable mineral. Unfortunately, as soon as a new use is discovered some scientist or near scientist immediately proceeds to patent the discovery with the expectation that some nation-wide industry will soon reward him with royalty tributes of exorbitant magnitudes. That line of precedure has seriously interfered with the plausible development of the mineral; but inasmuch as the patents on all of these unexploited processes will expire in due course of time, it is probable that the next decade will witness a decided increase of bentonite operations within the State. Fortunately, the Wyoming deposits are of ample magnitude to take care of all possible expansion regardless of how many additional uses may be discovered for the mineral in all years to come.

Recent Expansion of the Industry in Wyoming

Two plants for the pulverization and refining of bentonite continued operations throughout the year in Wyoming. The markets for their products are apparently expanding.

Owing to the fact that the management of the local companies have to develop their own markets, and inasmuch as their sales are not disclosed, no statistics are available on their production for the past year .

In addition to the refined products, several firms are known to have shipped the raw clay from Wyoming during recent years. In 1927, 146 cars of crude bentonite, valued close to $70,000.00, were shipped from the Clayspur, Jerome, Newcastle, Pedro and Upton sidings of the Burlington railway branch in northeastern Wyoming. All of this Wyoming mineral was destined to Nebraska and to other states as distant and widely separated as Illinois, Ohio, Alabama, Pennsylvania and California. As developments now stand, the merits of Wyoming bentonite should soon be known throughout the nation.

Wyoming Deposits Lead All States

Bentonite is another mineral that Wyoming leads all states in known reserves. At present, the big problem is to find markets for the vast reserves of Wyoming. If intelligent research work is directed, many new uses should be found for the mineral. For establishing new industries of steady and enduring life, no one can question the adequacy of the Wyoming stores of raw material. However, finding markets for minerals that are peculiar to Wyoming are tasks that Wyoming must solve by itself.

More Research Work Necessary

As soon as all the virtues inherent to bentonite are known, a far wider market is bound to arise for the mineral. Before its merits are fully disclosed, much research work of a time-consuming character remains to be done. So far, no federal or state agency have expended any funds to find out what uses could be made of bentonite. Like other branches of the mineral industry, the producers of bentonite have never appealed for public subsidies to finance research and publicity campaigns for the object of developing a broader market for their manufactured products. In the past eight year period, the giant mineral industry of Wyoming contributed the greater part of $49,000,000.00 wholly to pursuits that would promote the growth of longer cotton

strains in Texas and bigger and better apples in Oregon. Manifestly, until a far less altruistic attitude is assumed, the possibilities of some of the unique mineral deposits of Wyoming never will see the full light of day.

During the present year, various Chambers of Commerce of Wyoming have appealed to this office for aid in the development of bentonite deposits that have long laid dormant in regions directly tributary to their cities. In no instance could satisfactory replies be made to their inquiries. Naturally, present producing companies have no intentions of disclosing the character and scope of the trade that they alone developed for bentonite products. For finding new uses and markets, the Owyhee Chemical Products Company of Cheyenne has long been an outstanding leader in the American industry. So far, the research and sales departments of this company have developed more outlets for Wyoming bentonite than all other public or private agencies combined.

GRAPHITE

Natural Deposits

Amorphus graphite, or plumbago, is found in Fremont County near Miner's Delight, in the Haystack Hills near Ironton, in Goshen and Platte Counties, and in Albany County about 27 miles northeast of Laramie. The latter locality is called Plumbago Canyon because of the number of graphite deposits therein. Some development work has been done on these prospects in the early days. The material is mostly low grade and mixed with impurities. Of the deposits in the Haystack Hills near Ironton and Frederick the most promising are located in Section 1, T. 27 N., R. 65 W., and Sections 14, 15, 22, 24, 25, 26, 27, 34, 35 and 36, T. 28 N., R. 65 W. In this area the graphite occurs in schist in the immediate vicinity of granite and pegmatite. Low grade ore is found in comparatively large veins. The Miner's Delight is reported to be extensive and of good grade. No production is reported.

Manufactured Graphite

The deposits of graphite so far uncovered in Wyoming have generally been of the inferior amorphous varieties. The local market for these materials has at no time been active. From solely the better grade coals of Wyoming it would be possible to manufacture unlimited quantities of artificial graphite of a high quality by patented electrothermic processes. In all but two years since 1910, a single firm, the Acheson Graphite Company, manufactured more graphite at their Niagara Falls plant than the combined output of both amorphous and crystalline varieties mined in the United States. At the present time the trend of the market is unmistakably for the superior manufactured products.

Development of Hydro-Electrical Potentials Essential

In previous chapters the necessity of early development of the tremendous hydro-electrical possibilities of our exceptionally high gradient river courses was repeatedly stressed for the manufacture of divers abrasive, ferro-alloy, chemical, metallurgical, explosive, fertilizer, and pigmentation products directly from huge mineral deposits of unrivaled purity that lie within the larger stream valleys of Wyoming. For the establishment of a worthwhile graphite industry within the state, no single economic or engineering factor would likewise prove as important as the early development of our immense hydro-electrical potentialities.

GYPSUM AND GYPSITE

Gypsum, calcium sulphate, is one of the most common minerals of Wyoming. It occurs abundantly at the top of the Chugwater, or Spearfish formation and to some extent in the Embar or Park City formation. Deposits of this mineral have been reported from nearly every county in the State. The deposits of Albany, Big Horn, Carbon, Converse, Crook, Fremont, Hot Springs, Johnson, Laramie, Natrona, Park, Platte, Sheridan, Sublette, Washakie and Weston counties are all of inexhaustible magnitudes. At the present time the reserves of the Laramie, Medicine Bow, Big

Horn Basin, Casper and Sheridan districts appear to hold the most promise for early economic development.

Gypsite is gypsum earth resulting from the disintegration, soluton, and redisposition of original gypsum rock. Gypsite is never as pure as the original rock. In Wyoming, gypsite containing as high as 15% earth and other impurities is worked extensively. Due to the ease and exceedingly low cost that the soft earthy gypsite can be excavated, it, in lieu of the pure rock, forms the source of raw material for the gypsum industry as now developed in Wyoming.

Wyoming Leads All States in Gypsum Deposits

Beds of gypsum 10 to 20 feet thick are common and beds 30, 40 and some even 60 feet thick extend for miles in the State. Obviously, no geologist has yet taken the time to estimate the total quantity of these vast deposits. As a rule, text-book writers agree that the Wyoming deposits are the greatest known in the nation. So far, no Federal conservationist or popular magazine writer has ever become alarmed of a possible gypsum shortage occurring in Wyoming.

Recent Developments

During the year the United States Gypsum Company purchased the plant of the Overland Cement Plaster Company in Laramie. By this acquisition both the United States Gypsum Company and the Certain-teed Products Corporation are now conducting gypsum operations in the Laramie region. These two firms are the largest producers, manufacturers and marketers of gypsum products in America. Their sum total assets exceed $100,000,000.00. Obviously, no other firms are in a better position to develop the huge gypsum deposits of Wyoming. The invasion of this strong capital should do much good towards the development of the long dormant gypsum reserves of the State. The arrival of both of the big gypsum producers offers the brightest prospects for development and expansion the gypsum industry has even known in Wyoming. In course of time, these firms will likely establish additional manufacturing plants for the development of the huge gypsum de-

posits that are located in the Basin and other favorably situated regions of the State.

Present Production and Utilization

It is estimated that during the present year approximately 50,000 tons of gypsite was excavated in the Laramie district. All of this material was converted into plaster, soil fertilizers and other finished products by the mills of the two big gypsum companies. Most of these manufactured products were likewise sold outside of the State. For disposal of the products made in their Laramie plant, the United States Gypsum Company opened a new sales office in Omaha during the past summer.

In the Laramie and other mills of both the big gypsum companies that are scattered throughout the United States, over 100 different products, generally used in the fertilizer and building trade industries, are manufactured. By aggressive advertising and ultra modern selling methods, both of the big companies have built up distribution systems of broad dimensions for disposal of their products made in Wyoming and elsewhere.

Pioneer Development in Basin Region

In the Basin, gypsum products in the form of stucco cement, building blocks, plaster board, floor and roof tiling were made for home consumption during the past year. So far no outside market has been developed for the enormous gypsum deposits of this district. Doubtlessly the next plaster mill that locates in Wyoming will select the rapidly growing Basin region as a logical site.

New Uses

New uses for gypsum are constantly being reported. During past year a process appears to have been developed abroad for the conversion of gypsum into sulphuric acid as well as into soluble ammonium sulphate. If the final tests show that the process can be exploited commercially, the widely distributed gypsum beds of Wyoming will provide exhaustless raw material of the highest purity for the establishment of giant chemical industries.

Of the ten chemical elements essential to agriculture, the mineral gypsum supplies two; namely, calcium and sul-

phur. If the recently developed processes by which soluble phosphate is made without the use of sulphuric acid further expand, a new way will be opened to exploit the huge phosphate reserves of the state wholly by the consumption of Wyoming raw materials. These and similar technical advancements indicate that the giant mineral depository of Wyoming will some day provide an unsurpassable site for the location of a mineral fertilizer industry sufficiently complete to supply all possible requirements of the nation. In the Mineral Fertilizer chapter, in which all chemical elements consumed by plant-life are inventoried, other observations are filed in support of the preceding conclusion.

LIMESTONE

Directly flanking the granite cores of the great mountain ranges of Wyoming are huge beds of limestones of the Pennsylvanian-Mississippian series. At many places the railways of the state were constructed directly through scenic canyons eroded in these vast deposits of limestone.

Some of the larger beds of limestone are nearly pure calcium carbonate. Already, the exceptional purity of the Wyoming deposits has materially aided the establishment of the sugar refining industry in this and adjoining states. In the future the unusually pure limestones of Wyoming will do their share in attracting a wide diversity of industries to the Rocky Mountain region.

Throughout its period of pioneer development no market or demand existed for the limestones of Wyoming. However, at the present time new demands and uses are constantly being created for these exhaustless deposits.

Since the federal aid highway system was started ten years ago, large amounts of limestone in the form of crushed rock have annually been used in surfacing our improved highways. Also, during past decade many sugar refineries were erected in Wyoming as well as in the adjoining states of Nebraska, Montana and Colorado. For their refining operations the sugar mills of these four adjoining states now annually purchase from the Wyoming quarries 200,000 tons

of limestone of required purity at a price of not less than $1.50 per ton at the quarry.

The Ingleside Limestone Company, a Colorado corporation, is by far the greatest producer and marketer of sugar refining limestone in Wyoming. During 1927 the following record-breaking shipments were made from their widely distributed quarries in the State:

	Tons
Granite Canon, Wyo.	7,788.07
Altus, Wyo.	14,671.22
Horse Creek, Wyo.	72,048.98
Spence, Wyo.	7,418.72
Guernsey, Wyo.	65,542.46
Total	167,469.45

All of the foregoing production was bought by the largest beet sugar refining company of the Rocky Mountain area. Most of the mills of the latter corporation are situated in states adjacent to Wyoming and into which shipments of superior limerock can be conveniently made from the strategically located quarries of Wyoming.

As other new industries are established in Wyoming the demand for limestone will be multiplied many times. Already, the limestone consumption of our pioneer glass industry has been of appreciable magnitude. Incidentally, the law passed by the last legislature requiring coal mine operators to dust their mines with rock powder created a new domestic demand for Wyoming limestone. Moreover, as soon as the new cement mill starts operations at Laramie early next year, an additional one-half million tons of limerock will be pulverized and calcined annually by that plant alone.

In either the raw or calcined state, lime is one of the basic ingredients consumed in over 100 different ceramical, metallurgical, chemical, and other technical industries. In course of time the vast limestone deposits of Wyoming are bound to attract more of these modern industries. At the present time none of the Wyoming limestones are used for lime burning or for smelting fluxes. But as soon as chemical,

fertilizer and steel making industries are established in the State additional demands of wide extent will be created for these limestone deposits.

MICA

Muscovite mica is found in the Haystack Hills near Ironton and Frederick, Goshen County. It occurs in pegmatite dikes cutting pre-Cambrian schists. The principal deposits are in Sections 25, 26, 27, 34, 35, and 36, T. 28 N., R. 65 W., and in Sections 1, 2 and 3, T. 27 N., R. 65 W. Considerable development has been done on some of these prospects and some high grade sheet mica has been shipped. Probably high local transportation and freight rates are all that prevents commercial operations in this district. Important deposits of mica are found near Encampment, Carbon County, and in the Medicine Bow Mountains, Albany County, some of which have commercial possibilities. Veins of mica have also been discovered in the Casper Mountains, Converse and Albany Counties; in the Wind River Mountains, Fremont County; and in the Black Hills, Crook County.

Despite the superiority of the better known deposits development of mica mining has been painfully slow in Wyoming. In the past few years, carload shipments of grinding micas have, however, been made from both the Encampment and Wheatland localities. It is expected that the recent resumption of railway service to Encampment will again stimulate interest in mica mining. Some of the best deposits of the district are crossed by the right-of-way of the Saratoga & Encampment railroad.

Mica mines in Wyoming and other Rocky Mountain states are operated at a considerable disadvantage on account of the high freight rate to the eastern market. In working the Wyoming deposits it has as yet been impossible to utilize the feldspar and quartz, two minerals that are common by-products of mica mines. To make mica mining profitable in Wyoming, the establishment of pottery, glass and ceramic industries should be encouraged. Such industries would provide a local market for the associated min-

CHAPTER V

OTHER METALLIC MINERALS

In addition to the commercial ores so far reviewed, discoveries of bismuth, nickel, cobalt, molybdenum, tungsten, palladium, cerium, didymium, lanthanum, thorium, and yttrium minerals have been reported in Wyoming in times past. Investigations made by members of the present staff during the past 10 year period have generally found these depositions to be of extremely disappointing extent. As yet no prospecting operations of magnitude have been conducted for the search of these rarer minerals. Further explorations may, nevertheless, uncover commercial discoveries of the more common of these valuable metals within the Wyoming mineral depository.

Among the tables inserted in the appendix of this volume is the inventory of the United States Geological Survey, entitled,—"Useful Minerals of Wyoming." For the location of Wyoming depositions of all eleven metals mentioned in the preceding paragraph, the reader is respectfully referred to that official register of the Survey. Since assuming office two years ago, no time has been available to conduct studies of these little known mineral deposits. As matters now stand, the brief listings of the Survey must largely supply the extent of information available on minerals of high intrinsic value so far known to occur either in Wyoming or elsewhere in the United States only in extremely limited quantities.

Aside from molybdenum and tungsten, the American production of the eleven comparatively rare chemical elements mentioned may be considered negligible. Our more intensified mining state neighbor, Colorado, always leads in molybdenum and generally ranks second or third in tungsten production. The Colorado deposits are near Leadville,

Boulder and other points in the northern portion of the state. It is possible that similar geological conditions may in course of time be observed to prevail in the Encampment, Centennial and other highly mineralized areas that border the southern boundary of Wyoming.

CHAPTER VI

NON-METALLIC MINERALS

In addition to the ores of the metals described in preceding chapters, enormous stores of non-metallic minerals, likewise, occur in Wyoming. The exploitation of the latter form of deposits has recently been of sufficient magnitude to rank Wyoming among the leading mineral producing states of the Union. In the future the wealth yielded from these huge reserves of non-metallics will vastly exceed the sum total revenues that will be produced from all the metallic ore deposits that are situated not only in Wyoming, but also in adjoining states in which the mining industry has long provided a leading source of income.

In this section an attempt is made for the first time to classify the principal non-metallic deposits of Wyoming into well defined groups of closely related industrial products. Under this arrangement, separate chapters follow on Abrasive Materials, Ceramic Materials, Alkali and Saline Deposits, Mineral Fertilizers, Mineral Fuels, and other headings of similar significance. Some minerals of Wyoming are already utilized by two or more different industries. In those instances the complete description of the mineral will appear under the chapter classification in which its use is most extensive. Without adopting this procedure, it would be impossible to avoid a great amount of duplication.

In the comparisons and descriptions that follow, it will be disclosed that Wyoming leads all states in some of the most important forms of mineral wealth known to mankind. As classified and grouped in the following chapters every form of raw material consumed by entire fields of industrial activity will be found to occur in the complete depository of Wyoming in truly colossal quantities. In the following chapters all raw materials and sources of energies absorbed by some of the basic industries of the nation are inventoried.

In several instances all of these natural resources will be found to occur in the complete and consummate form only within the Wyoming depository. In lieu of cataloging highly technical descriptions of separate and detached geological deposits, the following chapters are written solely with the view of pointing out the unique advantages and inter-relationships that the wonder self-contained State of Wyoming offers for the establishment of industries on a scale and magnitude fully capable of meeting the entire market demands of the nation.

CHAPTER VII

ABRASIVE MATERIALS

Corundum, Garnet, Grindstones, Pumice and Pumicite, Artificial Abrasives

The leading natural abrasive materials of Wyoming include deposits of emery, garnet, grindstone, pumice and tripoli. So far, this office as well as the Government Survey have only made fragmentary and incomplete investigations of the abrasive resources of the State.

CORUNDUM

In United States Geological Survey Bulletin, No. 624, a deposit of corundum (emery) is listed as occurring in the Wind River range of mountains in Fremont County. As no further mention has been made of the deposit since the listed date of 1917, it is doubtless of too small extent to possess commercial possibilities. To date no samples of the mineral have been received by this office.

In recent years the manufacture of artificial corundum has become a tremendously more important industry than the production of the natural mineral, the occurrence of which is no longer adequate for present-day requirements. For making corundum of a quality far superior to that sold today, Wyoming can soon rely on an unique mineral deposition of exhaustless magnitude, the like of which is not found in any other state.

As in present producing localities, the future corundum industry of Wyoming will constantly lean more to the manufacture of the artificial product rather than towards the development of native deposits that are everywhere of limited extent and of a quality far inferior to the manufactured grade. In the sub-heading entitled, "Artificial Abrasives,"

Wyoming's future in the rapidly expanding corundum industry will be briefly outlined.

GARNET

At times garnet bearing deposits have been reported in areas of the State in which profound metamorphic disturbances occurred in the geologic past. The only garnetiferous properties that received notices in the press during the present year were those of the Cooney Hills Mining Company. According to recent despatches, the present plans of the company call for extensive development of their garnet and talc properties that are situated in the well known mineralized area that lays southwest of Wheatland. Specimens of the mineral brought to this office disclosed garnet crystals of good color about the size of a pea to occur in a schistose matrix. These crystals are said to be of sufficient hardness for the preparation and manufacture of first-class abrasive materials. Aside from their use as abrasives, the crystals on further optical and physical tests may prove of value as semi-precious **gem stones**, or at least serviceable for jewel settings for the cheaper grade of watch movements.

GRINDSTONES

In former publications, the United States Geological Survey reported a small production of grindstone from the Rawlins district. In recent years no quarrying activity for this material has been noted in the locality.

During last April, press despatches announced that H. S. Crispen had started the only grindstone factory in the entire Rocky Mountain region, at Lander. The rock from which the stones are shaped by cutting machinery is obtained from a sandstone deposit on Baldwin Creek. The samples so far produced are reported as flawless and to possess a superior cutting edge. As no other grindstone works are at present operating in the West, a local market of exceptionally wide dimensions should be developed for the finished products of the Lander plant. Not receiving samples for testing purposes, this office is still unable to issue a conclusive report on the adaptability of the quarried grindstone

as an abrasive agent. At the present time, grindstone rocks are largely graded on chemical tests that ascertain the character and percentage of the cementing material as well as on physical tests that record the size and shape of the component quartz grains.

PUMICE AND PUMICITE

An extensive bed of pumice from 4 to 6 feet in thickness is reported by the Geological Survey to occur in Albany County in the vicinity of Sportsmen Lake. At other places in eastern Wyoming, private geologists have reported the discoveries of huge beds of pumice and pumicite from time to time.

Pumice is a highly vesicular or cellular, glassy volcanic lava, usually rhyolitic in composition. Its cellular structure is due to the expansion, during cooling, of steam and gasses contained in the molten lava.

Pumicite, or what is now erroneously called volcanic ash quite generally, is a more or less finely divided powder or dust made up of small, sharp, angular grains of volcanic glass of about the same composition as pumice. It is formed by the violent and explosive eruption of volcanoes, which throws out this dust in great clouds. Ultimately, the dust settles, often many hundreds or thousands of miles from its original source, and forms beds of pumicite.

In Tertiary times the phenomenon of vulcanism thrived in Wyoming on a scale far more colossal than any similar disturbance yet recorded in the written history of the human race. During recent geologic periods, convulsions of confined cataclysmic forces threw up the lava flows that now form the spectacular and bizarre volcanic necks and knobs of the Leucite Hills region; the acid intrusives of Wyoming's sector of the Black Hills; the awe-inspiring phonolite laccolith now known as the Devil's Tower; and last but not least, the rhyolitic and basaltic sheets that make up the great Pitchstone plateau of the Yellowstone Park region. Accompanying those tremendous displays of terrestial fireworks were fair-sized volumes of fragmental materials ejected largely in the form of blocks, lapilli, bombs,

the so-called volcanic ashes (pumicite), cinders and the like. Apparently, in those days the prevailing wind direction was, likewise, from the northwest. At any rate, instead of remaining here the evil winds of that geologic period succeeded in blowing out of Wyoming an amount of volcanic dust sufficient to blanket half of Kansas and practically all of Nebraska with layers of pumicite that range from a few inches to over 80 feet in thickness. In all fairness to the winds of the pre-historic past, it should be mentioned that the thicker of these pumicite deposits were laid down quite close to the line that now forms the boundary common to Wyoming and Nebraska. However, it must be admitted that the farther the pumicite was blown out of Wyoming, the fineness and quality of the deposition generally improved.

Pure lump pumice similar to Wyoming grades is used as an abrasive for polishing various metals, alloys, woods, painted finishes, stones, porcelains, glasses, pottery and rubber product. In the ground form it is a constituent of ink erasers, tooth powders and other mildly scouring and cleansing preparations. In some foreign countries in which similar volcanic disturbances have occurred, block pumice in the hewn form is desired as a fancy and easily quarried building stone. A use for pumice of considerable future promise is the cement industry. As a matter of fact, buildings constructed of pumice cement by the Romans at the beginning of the Christian Era are still standing. In recent years patents have been taken out for pumice cements and mixtures of improved qualities. Kansas, which now leads in the production of the mineral as well as in research work relating thereto, has lately had occasion to believe that the cement industry will soon be the largest consumer of her deposits.

As listed by Ladoo, pumicite is used in making abrasive hand soaps, mechanics' paste soaps, silver and other metal polishes, dustless sweeping compounds, paint fillers, oil filtering compounds, and heat insulating materials. By far, most of the pumicite is consumed in the manufacture of cleansing compounds. Old Dutch Cleanser, a product familiar to most housewives, contains no less than 98% of pumi-

cite mineral. Other less widely advertised preparations have a pumicite content almost as high.

As now developed, fully 95% of the total pumicite production of America is mined, milled and marketed in the two nearby states of Kansas and Nebraska. Once upon a time, much if not all, of this air-borne abrasive material was emitted from volcanic vents formerly active within boundaries that now delineate the Sovereign State of Wyoming. On the higher plateaus of the State, windstorms still occur that inflict damages to growing crops as well as to the older and more fragile building structures. However, it may safely be presumed that many years will pass before any other tornado, cyclone or twister will descend with pick-up propensities sufficiently disastrous to transport bodily the basic raw materials of a modern mineral industry from original Wyoming locations to points fully 500 miles more convenient to the great consuming markets of the nation. Today, much is heard of the devious ways in which the water and other resources of Wyoming are constantly enriching the material prosperity of the older and more populous states. Geologically speaking, Wyoming started on that job long before the Indian and the buffalo came to these parts. Indeed, in Wonderful Wyoming more than poetic license exists for paraphrasing the old saw of the prophet to—"'Tis an ill wind that blows no state good."

TRIPOLI

From time to time former state geologists reported the occurrence of comparatively heavy beds of tripoli in the Sunrise and other localities of the State. Lack of inquiry apparently prevented prior incumbents from making field investigations of those deposits. As soon as some interest is displayed, this office will likely make inspections of the more important dicoveries recently reported in Wyoming.

As a matter of fact, visual inspections do not always suffice for the identification of tripoli. Before the qualities and adaptabilities of the Wyoming material for use as an abrasive agent can be finally established, a number of rather costly chemical, microscopic, physical, and industrial

mained intact and securely anchored within boundaries that now delimit the Sovereign State of Wyoming.

Hydro-Electrical Potentialities

In this as well as in preceding and subsequent chapters, frequent reference is made to the hydro-electrical possibilities of Wyoming. In the final section of this volume a more extended review of these potentialities appears under the chapter heading—"How Early Development of Wyoming's Hydro-electrical Resources Will Aid the Mineral Industry."

CHAPTER VIII

SALINE AND ALKALINE DEPOSITS

Sodium Chloride, Sodium Sulphate, Sodium Carbonate, Magnesium Sulphate. How the Vast Chemical Deposits of Wyoming Can Be Profitably Exploited.

Within the vast chemical laboratory of Wyoming many salt, sulphur, iron, alkaline earth, mud and hot springs naturally emerge to the surface in nearly every part of the State. In addition to the deposits formed from these mineral springs, there occur in Wyoming valuable and huge deposits of sodium and magnesium largely in the form of soluble sulphate and carbonate compounds. As a rule the latter deposits occur as surficial beds in small drainage areas or beds that have no outlet. Many of these beds are called "lakes," as they form in lowest parts of basins and during the spring and summer months are covered with shallow water.

Geology

In Wyoming thick deposits of high-grade sodium and magnesium soluble salts are found in the beds of dry lakes and ponds that vary from those of a few feet in diameter to some that cover several hundred acres in area. As they occur in all parts of the State, most of these alkali deposits appear to have a common origin. According to United States Geological Survey Bulletin No. 430, the alkali deposits occur in all formations above those of the Paleozoic age. They are most abundant in the Triassic beds but appear in all formations from the Paleozoic down to the soils of the present time—the Mesozoic and Cenezoic, containing many times as much alkali as the older formations.

In some localities the amount of alkali stored in clays and shales—the common source of supply for the leaching waters—is enormous. In the Red Desert, the alkali content

of the red pulverulent clay is as high as 30 or 40% of the total mass. Obviously, this exceedingly rich original material will never be exploited as long as the chemical pure soluble salts continue concentration and crystallization in the natural evaporation basins of the nearby lake-beds at a rate of accession far in excess of annual marketing demands.

Distribution

In a paper of this length it is not possible to record the names and locations of the thousands of mineral springs and alkali lakes that are found in every section of the State. Soda lakes of considerable size and importance are located in Albany, Carbon, Fremont, Johnson, Natrona and Sweetwater Counties. Of the counties mentioned, Albany, Carbon and Natrona contain the most numerous alkali lakes. Until the larger and more favorably situated deposits of these counties are exhausted, the remaining smaller and more remotely located lakes of the State can offer but little promise for economic development. In the ensuing remarks only the principal deposits of the leading saline and alkali chemicals of the State receive separate descriptions.

SODIUM CHLORIDE

Extensive beds of sodium chloride (common salt) of great purity occur in Crook County, west of the Black Hills and in western Lincoln County along the Salt River mountains. Salt springs and deposits are also found along the western state line, where Lincoln County borders Bannock County, Idaho. In that locality salt has been produced in both states for many years. The principal salt-producing area of Lincoln County lies south of Star valley on the route to Cokeville. In the past, salt developments of magnitude were located on Salt Creek in Sec. 26, Twp. 29 N., Rg. 119 W. In this locality the brine springs were found similar to the workable springs located on the Wyoming-Idaho border. Spring discharges indicate that heavy beds of rock salt underlie the Salt Creek area.

Estimates on the total salt resources of Wyoming are far from complete. In the workable areas along the Wyoming-Idaho border a Government geologist recorded the

total for both states at 5,000,000 tons. In the old days, before the advent of railroads in the west, relatively large amounts of salt were boiled from the brine springs of western Wyoming and hauled by ox-team to supply Idaho and Montana mining camps.

As yet, all salt deposits of Wyoming are remotely located from exisiting railways. Until transportation facilities are provided, only local markets will exist for the salt resources of the State. At the present time most of the salt sold in the State comes from the Great Salt Lake and from the brine beds of Kansas. Until additional railways are built, the supply of the neighboring states will likely remain cheaper than the salt produced in the more remote localities of Wyoming.

SODIUM SULPHATE

Wyoming is rapidly forging to the forefront as a leading producer of sodium sulphate. For 1926 the Federal Bureau of Mines reported that only two states exceeded the Wyoming production. Exact tonnage figures are not available from the Bureau, but at the present time approximately 6,000 tons of sodium sulphate is annually shipped from the State to eastern points, chiefly for the manufacture of stock food preparations.

No state is known to contain greater deposits of sodium sulphate than Wyoming. Until all of the lakes and other vast deposits that contain sodium sulphate are tabulated, it will be impossible to estimate the reserves of the State that total many millions of tons.

Location of Deposits

The largest, purest and best known sodium sulphate deposits are found in the Downey and Union Pacific lakes of Albany County; in the Lac de Smet region in Johnson County; on the Bothwell lands in Carbon County as well as in the Gill Lakes and in the Split Rock, Independence Rock and Sodium Station localities of Natrona County. Other important deposits are reported for Fremont, Park and Hot Springs Counties. These chemical lakes cover from a few to several hundred acres of land. In the Gill Lakes the

principal deposit has been opened up to a depth of 22 feet in the solid salt. In the most favorable settling basins the sodium sulphate crystallizes out in a high degree of purity. At other places the crystals are mixed with silt as well as with the salts of other soluble chemical compounds.

Present Production

In recent years the bulk of the State production was shipped from Sodium, a station on the C. B. & Q. R. R. about 33 miles west of Casper. The local deposit is situated a half-mile north of the railroad. It is owned by the Gill Soda Company of Cheyenne, who lease it on a royalty basis to a large manufacturer of prepared stock foods in Kansas City. The available reserves have been estimated at over 250,000 tons. The salt as excavated is nearly chemically pure and is practically free of silt impurities. The Gill Soda Company also have operated a nearby property known as the Gill Lakes in which the bed of sodium sulphate is the thickest known in the State. The larger property is 8 miles distant from the railroad and until their deposit along the railroad is exhausted, the more important reserves will likely remain idle.

Utilization

Sodium sulphate is a chemical that finds much use in the arts and industries. In the form of salt cakes it is used in making wood pulp paper, plate glass, window glass, bottles, water glass, sodium sulphide and other chemical compounds. It is also used in dyeing, in tanning and as a remedial agent in the preparation of modern stock foods. At the present time the entire production of Wyoming is consumed by the latter industry alone.

In the form of niter cake, sodium sulphate is used for absorbing ammonia as well as for the manufacture of modern fertlizer salts. For treatment of the ammoniated coals of Wamsutter as well as for the establishment of a complete fertilizer industry in the State the vast deposits of sodium sulphate offer much promise for Wyoming. In the future, the largest market for the chemical should logically be within the Wyoming Industrial Empire now in the making.

At the present time all of the sodium sulphate production is shipped out of the State. Beyond Missouri valley points the raw chemical enters into competition with salts admitted duty free from Canada and from more distant overseas ports. If adequate tariff provisions are ever arranged for the chemical, the exhaustless and easily recovered deposits of Wyoming should command due attention. While the chemical occurs in wide areas throughout the more arid west, it happens that the Wyoming deposits are situated nearest to the Atlantic seaboard. To date the latter region has offered the broadest market for the salt.

As soon as a complete fertilizer industry is established in Wyoming, more than two score of domestic and foreign patents of recent date will call for liberal applications of sodium sulphate for low-cost reduction of our refractory phosphate and potash deposits into the soluble compounds that are are directly assimilable by plant life. As yet neither this office nor any other scientific agency has conducted any tests to ascertain which of these late patents are most expedient for processing the complete and exhaustless mineral fertilizer resources of Wyoming.

Merely extracting the sodium sulphate for the object of shipping it outside of the State will scarcely provide more employment than an ordinary sand or gravel operation. On the other hand, if the raw chemical is utilized for the manufacture of the double super fertilizing salts of modern commerce, technical employment of a high order would be afforded for many residents of the State. Fortunately, huge deposits of this industrial chemical have been discovered in the Green River valley. In the latter basin the great deposits of phosphatic, potash and nitrogenous compounds of Wyoming also occur. As mentioned before, these mineral deposits provide all of the chemical elements of economic importance that are consumed by plant life.

SODIUM CARBONATE

Besides the surface alkali deposits or so-called soda lakes, numerous soda springs are scattered throughout Wyoming. These springs and soda deposits are too numer-

sodium carbonate would likewise be required by numerous American, German, English, Japanese, Italian and Scandinavian processes patented within the past few years.

Another sodium compound now used in all kinds of fertilizer extraction processes is sodium sulphate. As previously mentioned, in the Green River valley and other places in Wyoming, exhaustless supplies of this saline material, likewise, abound.

So far, many separate reports have been filed on the divers alkali and mineral fertilizer deposits of Wyoming. In past papers it has been the universal practice of Government and other geological experts to consider each single chemical deposit wholly as a separate and detached entity. That individualistic policy has already caused financial fiascos of a disastrous order to occur in Wyoming. In the past this office has witnessed costly attempts being made to produce both potash and alkali compounds in the Green River valley wholly in the light of independent, non-related, chemical enterprises. Suffice to state that until someone can demonstrate in a material manner the reactions of wide industrial application that take place when alkaline and fertilizing minerals common to Wyoming are brought together, lethargy, in lieu of logical economical development, will likely continue to rule within the vast chemical laboratory that forms the great State of Wyoming as a whole.

Aside from the Winter Research Bill, this office has not been cognizant of any steps ever being taken towards the practical solution of the greater chemical problems that still confront Wyoming. Should that measure ever cause a concourse of savants to convocate directly within the Green River valley, observant local residents would experience no difficulty in pointing out huge deposits of every chemical element that enters into the manufacture of all kinds of fertilizer and explosive agents. Instead of developing these unrivaled chemical deposits, America still suffers foreign domination for the supply of mineral fertilizers that forms the foundation of its food supply as well as for the cannon powder that would be consumed in event of invasion or attack.

MAGNESIUM SULPHATE

Geological publications generally concede that the Wyoming supplies of magnesium sulphate known locally as epsomite and in the realm of Pharmacopoeia as epsom salts are the most important in America. Nearly all of our thousands of alkali lakes contain this mineral which is easily separable from the other solubles by simple recrystallization processes.

According to Ladoo, the leading epsomite localities in the State are in Albany, Carbon, Converse, Laramie and Natrona Counties, principally in or near soda lakes. Brooklyn Lake, near Wilcox station, contains a large area of natural epsom salt. Another important deposit is at Poison Lake, 18 miles south of Douglas, where a mill was erected during the war period. Most of the epsomite in these soda lake deposits is mixed with mirabilite ($Na_2SO_4 \cdot 10H_2O$) or other less common soda salts.

Some lakes in Wyoming, however, contain epsomite almost exclusively and in a remarkable state of chemical purity. The Union Pacific Railroad has lately conducted a geologic investigation of the extensive playa lake deposits situated 16 miles northeast of Medicine Bow. Their chemist returned the following analyses for the solubles extracted from these heavily charged waters:

Analysis No. 129

Magnesium Sulphate	53.89%
Magnesium Chloride	0.38%
Water	45.67%
Insoluble	0.06%
	100.00%

Magnesium Sulphate	51.22%
Water	47.83%
Chloride of Sodium, Calcium and Magnesium	0.42%
Iron	Trace
Insoluble residue	0.08%
Loss	0.45%
Total	100.00%

These analyses indicate less than 1% impurities in the natural epsomite deposits. At times it is difficult to procure the refined product ordinarily sold as a remedial agent in a higher state of purity. The larger of the local lakes is said to occupy nearly 93 acres in extent. It contains a nearly saturated solution of magnesium sulphate. Its 7% content of the chemical starts to separate after standing 2 or 3 hours in a vessel container. During dry spells when the lake is at low level much of this material similarly crystallizes. A lake of this size manifestly contains many thousand tons of this easily recoverable, chemically pure salt. As yet the volume of water contained therein has not been measured by this office, but private geologists have estimated the weight of the contained soluble salt at no less than 1,500,000 tons. At the present time the larger of the local lakes is owned by Mr. William Calvert, President of the San Juan Fishing and Packing Company of Seattle, Washington.

Utilization

According to Ladoo, the principal use for the technical-grade salts seems to be in the tanning of leather. It is also used in warp-sizing cotton cloth; in loading cotton textiles; in dyeing; for weighing silk, paper and leather; in the enameling industries; in fireproofing compounds; in the manufacture of paints and soaps. The purified or U. S. P. grade is used mostly in the drug trade as a valuable medicinal product and in the manufacture of mineral waters.

In course of time distinctive local industrial uses of much promise should be developed for this important chemical directly within Wyoming. The mineral itself contains two of the ten chemical elements, namely magnesium and sulphur, consumed by plant life in attaining its organic growth. In many ways the soluble salt will be of value for the establishment of a complete fertilizer industry in the State.

Wyoming, like Germany, has no deposits of aluminum ores. However, it happens that both of those great commonwealths contain huge deposits of almost chemical pure magnesium salts. Being lately forced to procure a substi-

tute for almost every commodity, hard-pressed Germany has finally succeeded in strengthening her economic independence by making the metal magnesium, electrolyzed from her chemical salts, do the work of the aluminum formerly imported from foreign shores. In this age of aviation the latest substitute of the Germans has been found to possess merits decidedly superior to the original imported product itself. Both magnesium and aluminum are known for their lightness, but as the former is fully 40% lighter than the latter, it is evident that future air travel will demand that all metallic parts of both planes and ships be constructed of light-weight magnesium alloys almost exclusively.

Aircraft Industry Is Creating Big Demand for Metal

The latest use of magnesium is rapidly gaining and probably the future of the air industry is as much dependent on the general application of the new alloy as any other factor now under consideration. It is the only alloy to use for the construction of all-metal planes and since its adoption the construction of the all-metal dirigible has also been proposed. The Italian machine that General Pinedo flew to this country a year ago was to a large degree constructed of magnesium alloys. Moreover, the hulls of the air-boats that the German Dormier Company are now building, apparently for the object of removing all the thrills from future Atlantic flights, are necessarily made entirely of the new extra-light alloy.

Domestic enterprises have, likewise, not been slow in promoting the use of magnesium in the aircraft manufacturing industry. During the past year the American Magnesium Company made at their Niagara Falls plant a complete line of aircraft fitments, such as crank-cases, oil pans, pistons, control pulleys, gasoline line fittings, bearings, instrument parts, control levers, hinges, steps, propeller plate, and supercharger castings as well as a long list of light-weight non-aerial apparatus consisting largely of microscope parts, lens holders, field glasses, parts for motion picture machines and surveying instruments, golf-club heads, artificial limbs, impellers for compressors, shuttles and special bobbins. For electrolytic reduction to the metallic form,

crude magnesium salts had to be hauled long distances to the powerful hydro-electrical plants that operate their Niagara Falls works. Some day a modern traffic expert is liable to expose the economic follies that are involved by such needless transportation costs. In the meantime, constructive wisdom of a high order would be exercised if all the tax and mineral royalty payers of Wyoming would get behind our statesmen and insist upon early and immediate completion of the dual power and irrigation projects that are located particularly on the North Platte river at the Alcova, Seminole Mountain and other ideal box canyon sites still remaining undeveloped on that stream. Such development would immediately call for the reduction of the chemically pure magnesium salts heretofore described as being located near Medicine Bow, Douglas and other points directly within the local North Platte river basin. In other words, now is the time for Wyoming to get a secure foot-hold on the industrial end of the aircraft age yet to come.

At the present time magnesium metal is still selling close to $3,000.00 per ton. That price would allow ample margin to pay the freight from reduction works centrally located in Wyoming to the large plane factories already established on the Atlantic and Pacific coasts.

The present price for the metal merely seems high. As a matter of fact only a few trips would be required for a magnesium alloy plane to return its cost differential. The new light-weight alloy at last converts an airplane into an efficient transportation vehicle. The weight differential not only permits the carriage of more fuel for the long trips, but also, on all trips an extra pay-load of either passengers or freight could be carried. As yet the tariff revenues of airborne cargoes still remain comparatively exorbitant. All told, for the big developments in the coming aircraft age, mineral deposits still held in little esteem in Wyoming will probably be called upon to play a leading part.

Finally, all must realize that early development of the powerful hydro-electrical resources still remaining dormant in our major river channels is a matter that cannot be stressed too strongly at this time. If local development is postponed much longer, more populous states that pay no

mineral royalties to the Federal Treasury at all may see fit to develop a hydro-electrical industry of their own with no more worthy object in view than to reduce the chemical pure magnesium ores of Wyoming. If such a catastrophic economic dislocation is permitted to happen, Wyoming would at the best merely play the proverbial part of a drawer of water and a hewer of wood. As a matter of fact, our boggy saline lakes could be drained and their soluble solid content loaded aboard cars at an exceedingly low cost of operation. Between $3.00 a ton for the crude salt and $3,000.00 per ton for the reduced metal a decidedly visible price differential does exist. To bridge that gap it is NOW imperative that the powerful hydro-electrical resources of our streams be developed without further delay. Now or never is the time for Wyoming to obtain a secure foot-hold on the basically important magnesium metallurgical industry now rapidly advancing to the forefront in this strictly air-minded age.

HOW THE VAST CHEMICAL DEPOSITS CAN BE PROFITABLY EXPLOITED

The preceding fragmentary remarks do not begin to describe all of the important saline and alkaline deposits of the State. To give an account of all the springs, lakes, shale and fuel beds that contain deposits of these soluble salts would require the preparation of a separate volume far too bulky to be of interest to the general reader. However, elsewhere in this volume other soluble chemical salts peculiar to Wyoming are recorded. Perhaps the most important of these is the ammonium alum, tschermigite, that is described in the nitrogen chapter of this work.

As previously stated, in Wyoming occur natural deposits of salines of profound economic potentialities. In far less favored climes the manufacture of some of these salts form one of the most basic and extensive of all chemical industries. Outside of Wyoming more of these soluble compounds are contained in Germany than any other area already industrialized in a highly intensified manner. For many years Germany has been the chemical giant among the nations of the world. Her leadership began when peasants

first started to develop saline deposits in a small way about 150 years ago. Those humble operations proved sufficient to explode many of the hoary myths and dreams formerly held by the old alchemists. Also, on those original foundations now rests the entire structure of industrial chemistry as known today.

As yet the wonderfully complete line of saline and alkali deposits of Wyoming carry about the same degree of esteem as her classical and unmistakably visible oil structures received as late as 15 years ago. For both forms of deposits, Government and private geologists completed careful studies long before extensive exploitation actually started. As yet exploitation of the chemical deposits has failed to materialize. Before being rescued from their unduly prolonged state of dormancy it, however, happens that a host of problems remain to be solved. For the solution of the most pressing problems more reliance must be placed on the minds of the political economists and the technological experts rather than on findings of geologists that are already a matter of documentary record.

Of course in Europe the recovery and manufacture of saline and alkali compounds has long been an old and firmly entrenched industry. In America the new infant industry has a long way to travel before it will be entirely freed of foreign domination for even the source of its basic raw materials.

Recent Imports

One of the leading Wyoming salts that received description in preceding chapters was magnesium sulphate. From 1922 to 1925 the amount of magnesium sulphate imported for consumption in the United States varied from 8,211,228 to 25,390,734 pounds annually. It is extremely doubtful if the purity of the prepared imported salt could equal the almost chemical pure lake deposits that are found in Wyoming close to the railroads in the Medicine Bow and Douglas localities. As recorded, the foregoing import figures disclose that before America can establish a complete magnesium industry of its own, some far-sighted pathfinder will have to start the exploitation of the wonder Wyoming

deposits even if fair and adequate protection is unprocurable at this particular time.

Prior to preparation of this paper a conversation entered into with Dan W. Gill, the pioneer producer and shipper of sodium sulphate in this state disclosed that increasing foreign importations has within the past year or two restricted the highly profitable market that he, single-handed, developed for that alkali chemical of Wyoming. Had it been possible to conduct similar inquiries on the remaining chemical salts, almost exclusively found in the Wyoming depository, equally elucidating replies would have doubtlessly been received.

New Industries Require Protection

In the economic history of America there were periods when the steel, motor and other giant industrial enterprises of the present day had to receive full and complete protection from low cost products fabricated abroad. For the birth and creation of an alkali industry of similar national magnitude, the present American wage scale must demand an equal degree of protection first of all. As now developed, most of the larger chemical works established locations near the Atlantic sea-board. Even with present tariffs it is cheaper for those manufacturers to pay the duties on basic chemicals purchased abroad rather than pay the long-haul freight rates that would prevail if these salts would be shipped from their nearest domestic depositories out here in Wyoming. Had these lowly alkali salts always received the degree of protection due them, the great chemical manufacturers would have doubtlessly sought sites not far distant from the Wyoming raw materials for the location of their original plants. At the present time no one will blame existing manufacturers for hesitating to move their well organized businesses direct to the great natural depositories that are situated in Wyoming. However, to prevent economic dislocations of similar character in the future, the time has arrived for the broader-gauged statesmen of Wyoming to be on guard. All told, the problem of cutting down the increasing influx of raw chemicals prepared by low cost foreign labor must concern Wyoming far more so than any

other state. Instead of spreading farther inland, tariff differentials should restrict the future importations of chemical salts, peculiar to Wyoming, to points that merely fringe the Atlantic seaboard. In this connection it may be surprising to mention that the pioneer shipper of sodium sulphate in Wyoming was unable to extend his market east of the Missouri River during the past year. Economically and geographically speaking, the entire Mississippi valley should be rightfully included within his immediate trade territory for the exhaustless chemical deposits that are now under his proprietorship.

Technologically speaking, much missionary work remains to be done before a complete chemical industry worthy of its name can be organized in Wyoming. As conducted today, a fair sized operation would require an initial expenditure of one hundred million dollars. Merely to catalog all of the varieties of chemicals that abound within the natural laboratory of Wyoming will hardly suffice to attract the amount of capital mentioned. To expedite matters it may pay to add an alkali expert to the payroll of this office. If a gentleman can be procured who has contributed a laborious life to that highly specialized field of endeavor, it would be possible to list at least 101 different finished chemical compounds of high intrinsic worth that could be completely made in Wyoming cheaper than in any other state. Obviously, my technical staff has neither the time nor training to undertake such an arduous task at the present writing.

Favorable Location of Wyoming Deposits

Important inter-related situations largely of a geographic and economic order call loudly for the establishment of a chemical industry directly within Wyoming. Other states of the arid west contain some chemical deposits similar to those found in Wyoming. But it happens that none of those deposits are situated as close to the Great Industrial Empire of the East as those of Wyoming. Some of those deposits occur in states barren of fuel reserves. In Wyoming many alkali and saline lakes occur either on top or directly adjacent to huge gas structures. For direct separation of the one or more contained chemical solubles by

exactly controlled, fractional or repeated crystallization processes, no conceivable fuel would be more efficient than those tremendous reserves of low cost, directly applicable, supplies of natural gas that possess extremely high calorific values.

Necessity of Hydro-Electrical Development.

At present many foreign chemicals are hauled to Niagara Falls for reduction. The advantages of locally reducing our soluble magnesium salts to the extremely valuable metallic form has been discussed in this paper. For early establishment of a chemical industry from the grass roots to the final finished products the long battles that our present statesmen have fought for the immediate hydro-electricalization of the Green, North Platte and other key river courses of the state now promise seasonable rewards.

Potentially speaking, for the welfare of the Wyoming Chemical and Industrial Empire, no single force will prove as important as the immediate development and utilization of the vast hydro-electrical resources still remaining intact in our high-gradient river channels.

CHAPTER IX

CERAMIC MATERIALS

Natural Cement Deposits—Portland Cement Materials—Shale and Clay Deposits—Refractory Materials—Glass Making Materials—Pottery Materials.

An unusually wide and complete variety of ceramic materials are deposited throughout Wyoming. For a long time almost all of these deposits remained unexploited, but lately, an increasing interest has been taken in regard to their economic possibilities. In recent years some of these long dormant resources has caused the establishment of large industrial enterprises in different parts of the State. Their further development will go a long way towards making Wyoming a completely self-sustaining state.

A complete description of Wyoming's wealth in ceramic materials would call for the preparation of a separate publication of considerably greater bulk than this entire volume. Accordingly, in this highly condensed chapter attention can only be directed to resources already under active development as well as to a few deposits that promise industrialization at a comparatively early date.

NATURAL CEMENT DEPOSITS

From time to time the occurrence of natural cement deposits are reported from different parts of the State. As yet, the extent and character of only one of these deposits have been ascertained by actual drilling and chemical tests. This deposit comprises the 2,950 acre outcrop of Niobrara limestone that is situated 10 miles southwest of Laramie. During the present year its owners, The Monolith Portland Midwest Company, constructed a railroad from the deposit to their new cement mill recently completed in Laramie.