Volume Eighteen Number One

QUARTERLY

OF THE

COLORADO SCHOOL OF MINES

JANUARY, 1923

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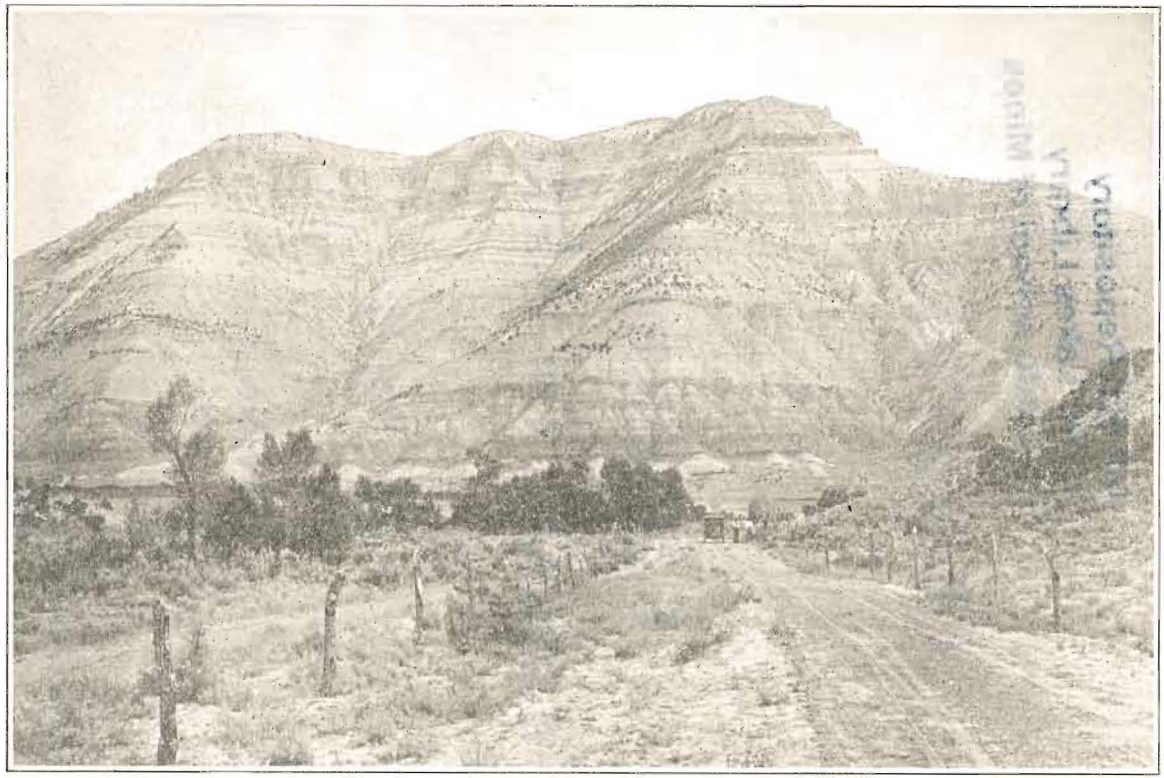

Oil Shale Cliffs on Parachute Creek, Grand Valley, Colorado.

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OIL SHALE

A Resumé for 1922

VICTOR C. ALDERSON
President, Colorado School of Mines

THE CLEVELAND CONFERENCE

The outstanding event of the year was the National Oil Shale Conference at Cleveland, in connection with the annual meeting of the American Mining Congress. The leading feature of the conference, aside from the general discussion and the reports of committees, was the paper on oil shale mining by William C. Russell of Denver—the most comprehensive discussion of the subject that has yet appeared. The proceedings of the conference have been published as Supplement B of the October, 1922, issue of the Colorado School of Mines Quarterly.

ARTICLES ON OIL SHALE

During the year there has been a decrease in the number of superficial articles on the subject, which are generally rewritten, diluted reproductions of standard articles, and an increase in the number of worthwhile discussions. The Quarterly of the Colorado School of Mines, the Railroad Red Book, and the U. S. Bureau of Mines have continued their regular contributions; the technical and oil press have had occasional articles; the Journal of the American Mining Congress and the Mountain States Mineral Age have organized oil shale departments and are publishing oil shale news and a current bibliography in each issue. The leading articles of the year have come from Columbia University and the Colorado School of Mines; that is, the doctor's dissertations by E. E. Lyder and Ralph T. Goodwin of Columbia University and the results of research work by Prof. Arthur J. Franks at the Colorado School of Mines. These articles are based on high grade, scientific laboratory research and form a distinct contribution to our knowledge of oil shale. It is noteworthy that the latest books on petroleum recognize oil shale as a coming feature in the oil problem; in each book on the subject published during the year are chapters devoted to oil shale; notably the recent treatises on petroleum by Day, Kewley, Redwood, Carlton and Meigs, which all devote one or more chapters to oil shale and thus recognize oil shale as a feature of the oil business that must be reckoned with.

PRECIOUS METALS IN SHALE

Reports have been made, by private investigators, that gold, silver, and platinum could be found in commercial quantities in oil shale. Much discussion ensued and conflicting reports were published. At the Colorado School of Mines, Dr. Albert H. Low, professor of Chemistry, and John C. Williams, at the Experimental Plant, made a careful examination of oil shale for the precious metals but reached only negative conclusions. Finally the

U. S. Bureau of Mines, at the Salt Lake station, made a thorough investigation and reported, in Serial 2413 by Supt. Thomas Varley, that the precious metals—gold, silver and platinum—did not occur in oil shale in commercial quantities.

ICHTHYOL Since the sixteenth century the Tyrolese peasants have been known to distill, in crude iron kettles over a wood fire, the local shale, rich in fossil fish, and to obtain a tarry oil which they used to cure sores and wounds on live stock. These curative effects were due to the antiseptic ichthyol derived from the oil shale, probably because of the excess of the fish remains in the shale. For this reason, Prof. Schroeter of Hamburg in 1890 gave the name "ichthyol" to the product. By "ichthyol" is meant, in general, a water soluble oil which is obtained by the distillation of bituminous shale and subsequent sulphonation and neutralization with ammonia or soda.

The first deposit to be developed commercially was at Seefeld, in the Tyrol, northwest of Innsbruck, on the southern slope of the Karwendel mountains. Similar shales are also found in the Tyrolese, notably at Kufstein, Thiersee, Brandenburg, and Munster. These deposits are thin, only from 4 to 19 inches in thickness, and yield from 6.5 to 10 per cent of oil. Their chief characteristic and the one which makes them valuable commercially, is the abundance of fossil fish remains, especially of the ganoid species. Up to 1919, 8070 tons of ichthyol shale were treated at the Ichthyol-Geschellschaft's refinery at Maximilianschutte. The refined oil was shipped to Hamburg to be treated for ichthyol.

On the German side of the Karwendel mountain, shales similar to the Seefeld shales are found in the valley of the Isar, which are also exceedingly rich in fossil fish remains and yield 30 per cent of oil. The development of these deposits is most extensive at Wallgan and was begun in 1920. The oil was distilled in horizontal revolving retorts and raw shale used for fuel. The ichthyol shales are also found in Switzerland at Meride, on Lake Logano, in the canton of Ticino. These deposits have been mined and the shale oil refined for a number of years by the Societa Minere Scisti Bituminosi and two thousand kilograms of ichthyol produced. In 1915, 484 tons were treated. Proximate chemical analysis of this shale gives:

Ash	47 per cent
Water	2 per cent
Oil	21 per cent
Carbonaceous Material	29 per cent

The crude oil contains 1.27 per cent nitrogen and 5.83 per cent of sulphur.

The Italian deposits are a continuation of the Swiss deposits, are of Middle Triassic age, resemble the deposits at Seefeld, and are found in the Province of Udine, at Giffone Valle Piana, Province of Salerno, and near Mollavo in the Trentino. In 1914, 55 tons of shale were mined from which two tons of ichthyol oil were obtained. The development of the deposits at Giffone Valle Piana was begun in 1915 by the Societa Chimiche "Itholo" and satisfactory results were obtained. In 1915 a retort was built at the mine and a chemical plant erected at Naples. Mining began in 1916, with an output of 110 tons and 134 tons in 1917. From 1913 to 1919 the production of ichthyol oil in Italy was 739 tons.

The ichthyol shale deposits of Germany, Switzerland, and Italy should be regarded as a special type of oil shale deposits, not known elsewhere, and not to be compared with the great deposits of Esthonia and the United States. They are found in thin beds, measured in inches rather than in feet, are rich in fossil fish remains, and are chiefly valuable for the ichthyol which may be derived from the crude oil. Information of the recent developments in these countries is meagre on account of unsettled local conditions.

MICROSCOPIC EXAMINATION To the popular mind, chemical analysis and practical distillation are the only avenues of approach to the study of oil shale. However, Dr. Bernard Thiessen in this country working on Kentucky oil shale, and E. H. Cunningham-Craig, and Harold E. C. Spence in London, have made careful microscopic examination of thin sections from widely different deposits and find that the approximate oil production of shale can be determined by the appearance of a thin section.

RETORTING Aside from the Catlin plant at Elko, Nevada, now operating on a commercial scale, and the Ginet and Brown retorts at DeBeque, Colorado, operating intermittently, considerable experimental work has been done on retorting on a commercial scale; notably by the Eastern Manufactury Co., Covington, Kentucky; The Searchlight Oil Shale and Refining Co., Pittsburgh; The Central Shale Oil Corporation, Pittsburgh; The Hoover Co., Chicago; The Day-Heller Engineering Co., San Francisco; The American Keroleum Co., New York; and the National Oil Shale and Refining Co., Buffalo.

The National Rotary retort, designed by J. B. Newberry, of Buffalo, is of the vertical type and consists of three essential parts: the shelves, the rotary case which carries 24 scrapers on each deck, and the stationary shell. The retort holds 400 pounds and has a throughput of 5 tons in 24 hours. The heat required for each ton of shale is 550,000 B. t. u. and is applied in the center of the retort. It is probable that the retort will be erected and used on eastern shales, presumably in Kentucky.

PATENTING OIL SHALE LAND Too much attention cannot be given, by those who hold oil shale land by possessory title only, to the subject of securing title in fee simple by patent from the government. Robert D. Hawley, an attorney of Denver, has given close attention to this subject and has issued the following principles:

First. Oil Shale is a separate and distinct mineral, having its own characteristics, just as gold, silver, and lead, are distinct minerals. A discovery of oil shale prior to February 25, 1920, was sufficient to validate a placer location. The Leasing Act of that date effected a withdrawal of all shale lands unappropriated when the law became effective.

Second. Under the Leasing Act of February 25, 1920, the Government became an adverse claimant to all oil shale locations. Locators, or their grantees, are bound to stand upon their rights as said rights existed at the time of the passage of the aforesaid Act.

Third. While a title in fee to oil shale lands may lawfully be acquired only by virtue of placer locations, yet the character of the mineral requires that the labor to be performed upon the claims be such as would ordinarily pertain to lode locations. The documents in connection with the application for patent must be prepared with this idea in view.

Fourth. Absolute certainty in mining titles prior to the issuance of patent is rarely attainable and every possible step should be taken to insure reasonable certainty. Where in connection with the performance of labor or the preparation of documents, there are two courses open to the claimant, one of which has been shown by precedent to be reasonably safe, and the other is doubtful, the safer course should be followed always.

Fifth. The honesty, integrity, and efficiency of all persons connected with the making of the locations under consideration, and the placing of improvements thereon, should be established. Locations, alleged to have been made by a person or persons who on one day will swear under oath to a statement of facts to influence a prospective purchaser and who, on the next day, will repudiate the statements so made to an agent

of the Government, will probably never be patented. A most important step in connection with an application for patent to a mining claim is an examination of the title to the claim. This is a much more complicated and painstaking task than the ordinary examination of title to real estate. The abstract is merely an outline or memorandum. It may show a clear chain of title and may be based on records senior to other records on the claim and still the title may be absolutely worthless. The documents should in each instance be examined, preferably by the original, but if the originals are not available then by the record. It is indispensable to security to know what has been done upon the ground. We must know the time, place, and manner of making discovery, and whether the land embraced in a claim is chiefly valuable for oil shale. We must know whether the location notice was duly posted and what it contained; whether the stakes were properly set; whether there are upon the ground any notices or improvements which would indicate the presence of hostile claims, and, if hostile claims are found, their seniority or juniority should be established.

In order to determine whether or not the claims were valid in their inception, it is necessary to know that each locator—

(A) Was at the time of the location a citizen of the United States, over the age of 21 years;

(B) Was a bonafide locator in his own interest, and in the interest of no one else whomsoever;

(C) Advanced his proportion of all expenses in connection with the making of the locations, either in money or labor; said proportion being equal to that of each of the other locators;

(D) If the interests of the locators have been disposed of, that he received his full share of the proceeds.

FACTORS AFFECTING

Dean E. Winchester has carefully considered the factors which affect the value of oil shale land and has summarized his conclusions as follows:

A Thickness and richness of the oil shale beds.

B Geological attitude of the oil shale beds; dips, faults, and other characteristics.

C Persistence and uniformity of oil shale beds in thickness and richness.

D Relation of oil shale beds to the surface, as influencing the method of mining.

E Topography of the tract and the position of the oil shale outcrop.

F Total area of lands underlain by oil shale, available for mining operation.

G Physical character of the oil shale as influencing mining, crushing, and transportation.

H Chemical character of the oil shale as bearing on its behavior in the retorts and on the character of the products of manufacture.

I Location of lands with regard to transportation, present and possible.

J Location of lands with regard to available water supply.

K Location of the lands with respect to supply of mining timber.

L Location of the lands with respect to lands available and appropriate for plant site, camp site, and waste dump.

M Location of the lands with respect to markets.

N Value and demand for products possible to manufacture.

O Location of property with respect to labor, machinery, and miscellaneous supplies.

He has also computed the relative value of the oil shale deposits in six states. Inasmuch as the average yield in Colorado is the greatest, this is taken as 100 per cent and the average yield in each of the other states is compared with the average in Colorado. It should be observed that richness and thickness alone are considered in this comparison.

Approximate Relative Value of the Oil Shales of six states:

State	Relation	Approx. Area Involved
Colorado	100%	900,000 acres
Kentucky	27%	609,686 acres
Utah	20%	2,700,000 acres
Indiana	20%	320,000 acres
Wyoming	9%	500,000 acres
Nevada	8%	1,000 acres

He concludes:

"When all the influencing factors are taken into consideration the Colorado oil shale lands must be placed at the head of the list of desirable properties for development."

INDIANA The main oil shale deposit of Indiana is a continuation of the Kentucky deposit which crosses the Ohio River at New Albany and extends north for a distance of about 50 miles, east and west from five to ten miles, and covers an area of 500 square miles in Jennings, Jackson, Scott, Jefferson, Clark, and Floyd counties. The same deposit outcrops in the northeastern part of the state on the banks of the Wabash river. Streams have cut into the shale in many places and left bluffs from 30 to 70 feet high. The average thickness of the shale outcrops is 50 feet. The yield of oil, as determined at the University of Indiana, is from 6 to 14 gallons to the ton, according to John R. Reeves, Director of the Oil Shale Experimental Station. Although the yield of oil is low, yet other factors like homogeneity and thickness of strata, quantity available, accessibility, ease and cheapness of quarrying, and high nitrogen content may make these deposits eventually attractive from a commercial point of view.

OHIO The oil shale deposits in Ohio, that are most accessible, extend from Chillicothe south to the Ohio river, through eastern Adams county and western Ross, Pike, and Scioto counties. The thickness varies from 300 to 500 feet but the oil yielding qualities of the strata vary greatly. The Sunbury shale, from 15 to 25 feet in thickness, is available for exploration throughout most of the area. An experimental retort, treating Sunbury shale, near Omega in Pike county, yielded from 20 to 25 gallons to the ton. Another retort is now being erected at Buena Vista.

KENTUCKY Much attention has been drawn to the oil shale deposits of Kentucky chiefly because of the vigor with which Prof. C. S. Crouse, of the University of Kentucky has undertaken field work and laboratory investigations. The Kentucky deposit forms the largest and richest part of the Devonian uplift and surrounds, in knobs and cliffs, the blue grass region. The outcroppings extend across the Ohio river and there comprise the oil shale deposits of Ohio and Indiana. The yield is on the average half a barrel of oil to the ton but advantageous economic conditions make the deposit, on the whole, valuable and easily workable. In the laboratory of the University a new retort is in operation and under development which bids fair to be successful.

The National Retorting and Refining Corporation of Buffalo is contemplating the erection of their Newberry retort in this field. The Central Oil Shale Company of Pittsburg is also contemplating the develop-

ment of its property. The full extent of the Kentucky shales can be realized only by the fact that they can yield four times as much oil as now remains in all the known oil pools of the United States.

CALIFORNIA The Day Engineering Company has designed a vertical retort, which may be properly described as a modified Scotch retort, with increased capacity and greater efficiency. A plant at Santa Maria is projected to have a daily capacity of 400 tons.

The Geological Department of the Southern Pacific Company is now engaged upon a field survey of the entire land holdings of the company in order to determine the extent and character of its oil shale resources. The company is acting with great foresight because it must have a second line of oil resources when the well oil production of California has passed the peak. The field work of the Geological Department will cover rough field tests, supplemented by check work at the Experimental Plant of the Colorado School of Mines.

MONTANA The oil shale deposits formerly owned by the National Oil Company of Dillon, Montana, have been acquired by the Chicago-Dillon Oil Shale Company with headquarters at Butte. Development work is planned together with the erection of a retort of the type erected at Fort Wayne, Indiana, by the Koppers Company of Pittsburg.

NEVADA After six years of experimental work on a commercial sized plant R. M. Catlin has placed his plant at Elko on a basis of regular commercial production. The underground development consists of an incline 400 ft. long with drifts at each hundred feet extending 500 feet each way from the incline. The daily production is 100 tons. Two new circular, vertical retorts, each 14 feet in diameter and 47 feet high, are now in operation. The surface equipment includes an 8000 and a 6000 barrel tank for crude oil, two 200-barrel stills, a refining plant using the standard acid and soda method, and a wax plant. The shale yields 40 gallons to the ton of oil with a distinct paraffine base. The products are gasoline, lubricating oil, and wax. The gasoline and lubricating oil are used successfully at the plant itself and also have a ready local market. The retorts furnish sufficient oil and gas for all fuel purposes. The work at the Elko plant is epoch making in that it records the first oil shale plant of commercial size to be operated in the United States. Other oil shale deposits are known to exist in Nevada but they have not been exploited. A plan is now being developed to make a survey of the entire state and to test the oil shale deposits for their oil content. The absence of coal in this section of the country makes an adequate supply of crude oil especially desirable from an economic point of view.

UTAH Utah is noted more for the laboratory investigations made at the United States Bureau of Mines station at Salt Lake than for development of oil shale deposits in the field, although the state has rich and extensive deposits. These deposits are estimated by J. B. Jenson of Salt Lake as follows:

Field	Acreage	42 Gallon Strata	Total Bbls.
Soldier Summit	50,000	20 feet	2,178,000,000
Uintah Basin	125,000	30 to 60 feet	10,890,000,000
Watson and White River	50,000	30 to 50 feet	3,267,000,000
Naval Reserve	92,160	40 feet	8,016,040,000
Totals	317,160		24,351,040,000

The most striking publication from the station is that by Superintendent Thomas Varley in which he, after careful investigation, puts a quietus upon the extravagant claims of individuals who have reported

precious metals in commercial quantity in oil shale, recoverable by a secret process known only to themselves.

COLORADO The oil shale deposits of Colorado if viewed from the point of view of richness in oil, extent of area, thickness of strata, accessibility, cheapness of development, and general economic advantages form the greatest potential natural asset of the state. They rank with the best oil shale deposits found anywhere in the world. Geologically, they form a part of the Uintah basin that stretches westward into Utah and northward into Wyoming. Within Colorado the deposit is divided into three main sections, so divided because of the natural entrance to them. The Battlement mesa section, which extends south of the Grand river, can be approached through many valleys and ravines; the Roan creek section through DeBeque; and the Parachute creek section through the town of Grand Valley. Politically, these deposits are in Garfield, Grand and Mesa counties. The Denver and Rio Grande Western Railroad passes through the valley of the Grand river and touches the important towns of the district. Thus the entire deposit is within a few miles of transportation over a transcontinental railroad. During May and June, 1922, more than 250 men were employed in doing oil shale development work for more than a hundred owners in the DeBeque-Grand Valley district.

Two commercial sized retorts have been erected at DeBeque; the Brown and the Ginet. The Monarch Shale Oil Company has erected a Ginet retort of a minimum daily capacity of 50 tons. It is of the circular, horizontal, stationary type, 25 feet long and three feet in diameter. The only fuel used is the fixed gas produced from the shale itself. The shale is mined from an eight feet stratum, 1000 feet above the retort, that yields 60 gallons to the ton. The Washington Shale Oil and Products Company of Seattle, Washington, is erecting a Ginet retort to have a daily capacity of 200 tons. Machinery is now on the ground and construction is going forward.

The Index Oil Shale Company has erected a Brown retort. This is of the horizontal, revolving, internally heated type with three successive cylinders, from each of which the products can be drawn off. The company has recently erected a topping plant to produce gasoline which is sold to the local trade. The retort will not be operated continuously until the mine is opened and a tram erected to furnish a regular supply of shale economically.

The records of the United States Land Office at Glenwood Springs show that on Nov. 10, 1922, in the oil shale section of Colorado, 25,901.82 acres of oil shale land have been patented. In addition, final certificates have been issued for 15,887.88 acres and applications pending aggregate 6,850.80 acres more. The largest holders are the Colorado Carbon Company, and the Ventura Consolidated Oilfields Co. at DeBeque, and the Union Oil Company at Grand Valley. Of these the Union Oil Company alone has taken 16,011.16 acres to patent and approximately 4,000 acres more are in progress. This company has spent a large amount of money, estimated at a million dollars, in acquiring land, doing assessment work, and taking land to patent.

The Ventura Consolidated Oilfields Company has made application for government patent on 5,000 acres in addition to the acreage applied for in 1921. The holdings of this company on Brush creek amount to approximately 10,000 acres, all of which has been fenced at a cost of $7,000.00. In addition to the oil shale land acquired, the company has purchased adjacent ranch and grazing land so as to have control of all the natural advantages of a large tract. To test the deposits accurately diamond drill holes have been put down so that the company has secured exact and detailed information of the thickness of each stratum of oil shale, its oil yield, and its geographic extent.

OIL SHALE PRODUCTION The following estimates as to oil production are based upon complete sections and tests of the oil yielding strata in Parachute creek, Grand Valley, Colorado, by A. S. Crossfield.

A. Mining and treating shale from the richest part of the section.
Thickness mined (average 58 gal. per ton) ..... 8.5 ft.
Oil content per acre ..... 25,750 bbl.
Production per acre based upon mining 90% of shale in ground ..... 22,895 bbl.
Oil content of shales not mined.
Beds 6 feet or more thick yielding 20 gal. or more 100,000 bbl.
Beds 6 feet or more thick yielding 15 gal. or more 162,000 bbl.

B. Mining and treating shale from main rich bed.
Thickness mined (average 45.5 gal. per ton) ..... 23.5 ft.
Oil content per acre ..... 53,425 bbl.
Production per acre based upon recovery of 70% of shale in ground ..... 37,397 bbl.
Oil content of shales not mined.
Beds 6 feet or more thick yielding 20 gal. or more 73,000 bbl.
Beds 6 feet or more thick yielding 15 gal. or more 134,900 bbl

C. Mining and treating shale from 49 ft. thickness.
Thickness mined (average 35.5 gal. per ton) ..... 49 ft.
Oil content per acre ..... 63,175 bbl.
Production per acre based upon recovery of 65% of shale in ground ..... 41,063 bbl
Oil content of shales not mined.
Beds 6 feet or more thick yielding 20 gal. or more 40,000 bbl.
Beds 6 feet or more thick yielding 15 gal. or more 101,000 bbl.

PANAMA At the Cleveland Conference, an American engineer, Mr. Wilcox, operating in Panama, reported the discovery of a commercial body of oil shale in Panama, about six miles square, twenty miles from the coast. The deposit has not been thoroughly tested but it is reported to be of high grade. The absence of coal in Panama and the high price of gasoline, 60 cents a gallon, may render this deposit of value.

CANADA The D'Arcy Exploration Company of England erected a Wallace retort near Moncton, New Brunswick and carried on experimental work from April until December, 1922. George Howell of London estimates that in New Brunswick 200 million tons of shale of commercial value will be found, provided successful retorts are designed and working costs are kept down. Of still greater importance is the action of the Anglo-Persian Oil Company in entering the Pictou oil shale field in Nova Scotia. The project involves an ultimate outlay of $25,000,000 of which one million is immediately available. A subsidiary company—the Oil and Nitrate Company—will have immediate charge of operations. The plan involves the erection of a plant to treat 2,000 tons a day, together with the accessory refining units. The deposit to be worked is estimated to contain two billion tons of shale of an average yield of 50 imperial gallons to the ton. The Pictou shales contain the famous "stellarite" a very high grade oil shale comparable to the Scottish "torbanite." This "stellarite" was mined and shipped to reduction plants on the Atlantic Coast sixty years ago, before the oil wells of Pennsylvania were discovered. With ample capital, competent technical and engineering ability, and a rich raw deposit this venture should certainly succeed.

BRAZIL The failure of drilling operations to find liquid oil and the absence of extensive coal areas have drawn attention to the oil shale deposits of Brazil. A concession has been granted to a British

syndicate for the development of the oil shale at Belle Vista in Rio Grande Do Sul. It is expected that within two years 1000 tons of shale will be treated daily and not less than 500 men employed. Inasmuch as Brazil has no well oil and little coal the fuel problem is exceedingly acute. The development of the oil shale industry will not only provide oil and its products but will make the country independent of foreign supplies.

CHILE J. M. Gavin, an American engineer at Antofagasta, Chile, reports oil shale on the "Pular" company's property and describes it as follows:

"The shale is situated on the western slope of the Andes about latitude 24° south, at an altitude of 13,000 feet, 130 miles from the coast, and 60 miles from the nearest railroad. It overlies igneous rock, the outcrop being about north by west and the dip about 45° towards the west. The length is about 5 miles, of which about 3 miles is petroliferous, and the total thickness about 1200 feet, 900 feet of this being shale and the remainder interposed beds of sandstone and limestone." A sample tested at the Colorado School of Mines gave 28 gallons to the ton.

FRANCE The Societe Lyonnaise de Schistes Bitumineux, with headquarters in Paris, opérates in the Autun basin. The company mines the shale, retorts it, and refines the oil. The retorts are of the vertical type 60 feet high, use steam, and produce not only oil but ammonium sulphate. The company has three production plants, at Morganue, Telots, and Ravelon, and a refinery at Sant-Leger-Sully.

Encouraging news comes from the Var Oil and Coal Co. in the annual report to the shareholders December 22, 1922. This company has large coal and oil shale properties in the Autun region in southern France. The shale deposits are popularly known as the "rich Boson Shales" because they yield on test 65.8 gallons to the ton. Extensive experimental work by the technical staff, headed by Dr. H. V. Dunham of New York, showed that the use of the vertical, slow acting Scotch retort was unsuited for shales rich in oil yielding elements, on account of the tendency to swell and stick fast in the retort. A new twin retort has been designed, erected, and tested to the complete satisfaction of the consulting engineer, Ronald Johnstone, of London. This retort is of the horizontal type, continuous in operation, thermally self-supporting, and yields an exceptionally good sulphur free oil. In ordinary fractionation it yields 30 per cent of gasoline but a cracking plant is to be installed to increase this yield. The initial capacity of the first commercial plant will be 50 tons a day but the mine development will be extensive enough to supply 300 tons of raw shale daily. Additional retorts will be erected and the largest possible output of gasoline maintained to meet the constantly increasing demand. The results of the work of the Var Company are exceedingly gratifying to all who are interested in seeing the oil shale industry established on a successful commercial basis.

GERMANY The war taught Germany the need of a domestic supply of oil. Consequently, with characteristic thoroughness she has begun the systematic development of her oil shale deposits, has experimented on retorting and refining till she seems to be in a fair way to supply her domestic need of oil and oil products from her own natural deposits of oil shale. Aside from the ichthyol shales, deposits are known to exist in Wurtemberg, Baden, Beyern, Hessen, Saxony, Hanover, Braunschweig, and Prussia. They are generally of a lime-clayey form, of medium thickness, and yield a fair amount of good oil. In the Jura mountains, in Bavaria, the oil shale yields six per cent of crude oil. Production is controlled by the Bayerische Mineral Oelwerke which has erected plants in Upper Franconia for refining the oil into gasoline, benzine, parraffin, lubrication oils, and other products. The company

holds 2700 acres of land. Good deposits are found near Reutlingen which yield 230 litres of oil to the metric ton. The Jura Oelschiefer Gesellschaft has been organized to exploit these deposits, in cooperation with the government of Wurtemberg. The oil shale beds in Hessen, near Darmstadt, yield 14 per cent of oil. The deposits in Saxony, Hanover, and Braunschweig are of about the same grade.

At Messel, near Darmstadt, an oil shale deposit has been worked since 1885. It is 150 meters thick and only 4 meters below the surface of the ground. It yields from 6 to 10 per cent of oil, of density from 0.855 to 0.860. From 100 kilograms of shale, 30 cubic meters of gas are produced.

In Wurtemberg, a deposit yields 10 per cent of oil. Luxemburg has a similar shale that yields from 2.3 to 5.1 per cent of oil of a density of 0.955.

Although recent official figures of the oil shale industry in Germany are not available, yet sufficient information has been obtained unofficially to warrant the belief that the industry is making rapid and satisfactory progress.

SWEDEN The researches of Messrs. S. Bergh and K. Larson, Swedish engineers, bid fair to result in a process for the commercial development of the Swedish oil shales. The process, developed under the guidance and assistance of the officials of the Stockholm gas works, but under the direct control of the Swedish Institute of Engineering Research, is a combination retort and fire box. The time of distillation is reported to be less than by older methods. The expense of the work has been met by a Government grant. The deposits of oil shale at Kinnekulle, Narhe, and Ostergotland are enormous. Since no well oil is produced in Sweden and oil and all its products have to be imported the establishment of a domestic oil shale industry will be of great economic advantage to the country.

SOUTH AFRICA The development of the oil shale industry in South Africa takes on unusual importance because of the unlikelihood, according to E. H. Cunningham-Craig, the English authority, of finding well oil in that region. The oil shale deposits are located in Natal, in four areas; the Wakkerstrom, the Ermelo, the Hlatimbe Valley, and Impendhle county. The South African Lubricants and Chemical Works, Ltd., has done considerable prospecting work on the Hlatimbe Valley shales. Six thousand seven hundred acres are known to be underlaid with oil shale. A full section of the strata is exposed in a deep valley. The strata have been proved, by adits and cuttings, for a distance of 7000 feet and average three feet in thickness. It is estimated that on this 7000 feet alone seven million tons of shale are available, aside from 57 claims which, although not yet proved, yet give indications of being equally as good. In such case fully forty million tons of oil shale will be available. The oil yield is 20 or more imperial gallons to the ton. Treatment works are projected on a large scale.

The Ermelo district, reported on by J. E. Mills Davies, covers an area of 6000 acres and has a recoverable oil content as follows:

	Volume	Yield Per Ton
1.	38,400,000 tons	18 gallons
2.	38,400,000 tons	28 gallons
3.	16,800,000 tons	27 gallons
Total	93,600,000 tons	

The Slangapies Coal and Oil Shale Corporation—an English company capitalized at $150,000—has been organized at Natal, South Africa, to explore and develop 40,000 acres of promising oil shale land. The

tract has been opened in several places, sufficient to warrant expectations that the entire tract will prove to be valuable oil shale land. It is adjacent to the oil shale holdings of the Royal Dutch Oil Corporation which already show promising results. The prospectus of the Company says "The need in the near future of further large reserves of oil is recognized by all those engaged in this business and the growing demand for oil and the products of oil already reaching the sum of nearly four million pounds sterling per annum imported into the Union of South Africa insures a market, apart from an export trade which will undoubtedly follow."

The African Oil Corporation, the chief oil shale company of the region, is developing the deposits in the Wakkerstrom district, southeast Transvaal. A shipment of 30 tons has recently been sent to England for test. Recent development has shown two veins of shale, one 17 inches thick yielding 40 gallons, and one 20 inches, yielding 15 gallons. A new oil shale company under the title of the Orange River Oil Shale Syndicate has been organized to test a bed of shale in the Harroo formation in the Northern Cape province.

The government pays a bounty of 62.5 cents a gallon on the first 3,500,000 gallons of crude shale oil produced; 50 cents a gallon up to 5,000,000 gallons; 43.75 cents a gallon up to 8,000,000 gallons; and 35 cents a gallon for each additional 5,000,000 gallons produced. The government also encourages bona fide organizations that look to the public for financial support provided they made no attempt to deceive the public by issuing imaginative estimates of possible commercial profits.

AUSTRALIA The Joadja oil shale mine in New South Wales, which was formerly operated by the Australian Kerosene Oil and Mineral Co., but closed about 20 years ago as a result of American competition in oil, is now being reopened by the Shale Petrol Oil Co., Ltd., a new company that proposes to mine the coal, which occurs abundantly on its property, as well as the shale. The mine is situated near Mittagong, on the main line between Sydney and Melbourne. On distillation, the shale gives 73 per cent of volatile hydro-carbons and an average of 106 gallons of crude oil. The old company produced considerable quantities of motor spirit or gasoline, which in those days was regarded as a nuisance and therefore was burned on the spot. A new company, the Oil Shale Products and Coal Company, is now working at Joadja, producing 700 gallons of crude oil a week, but it is hoped to increase this output to 15,000 gallons a day, for the work is still in the experimental stage. The best quality shales at Joadja give the exceptionally high yield of 180 gallons a ton, while the minimum yield seldom goes below 80 gallons.

In another part of New South Wales—the Wolgan Valley—the Commonwealth Oil Corporation proposes to test a scheme devised by its manager, John Fell, in which retorts will be done away with altogether. The idea of burning the shale in situ is not new, but the successful carrying out of this idea on a large scale would undoubtedly be novel. Portions of the shale have already been fired. The idea is to make the valley a vast natural retort and the gas produced used in gas engines for generating electricity. The idea is idealistic, somewhat fantastic, and will be watched with unusual interest. During the month ending June 16, 1922, the Commonwealth Oil Company mined 1973 tons of shale and retorted 2023 tons. Two hundred thousand gallons of crude oil were produced, or approximately a hundred gallons to the ton. During the month ending July 14, 1922, the company mined 1935 tons, retorted 1944 tons, and produced 195,603 gallons of oil. It is conservatively estimated that there is sufficient oil available from shale in New South Wales to make all Australia independent of foreign oil importation if the processes now being tried out prove successful.

TASMANIA The Geological Survey Branch of the Tasmania Mines Department has become convinced of the uselessness of seeking for oil pools in Tasmania but is on record as believing that the oil shale deposits form a valuable national asset. For this reason field work to examine the deposits of Tasmania is included in the work of the survey. This work will cover not only the external examination but the sinking of bore holes so as to get exact information not only of the oil content of each stratum but also its thickness and geographical extent. Provision has also been made for the investigation of retorts and refining. The work will be under the general direction of C. Loftus Hills, Director of the Geological Survey. Aside from the Governmental work the Railton-Latrobe Company is in active operation, mining and retorting shale in its plant of 350 tons daily capacity. The crude oil is shipped to Melbourne for refining. The oil shale deposits of the company are estimated to contain more than seven million barrels of oil.

The Victas Oil Shale Co., Ltd., has acquired 1500 acres of oil shale land near Latrobe and is taking active steps to develop its property. The "tasmanite," as the oil shale is termed, has been investigated by experts who look favorably upon it. Dr. Arthur Wade reports on the calorific value of the crude oil in the Railton-Latrobe area compared with the calorific value of other oils as follows:

Tasmanite crude	22,000 B.t.u.
Scotch shale oil	18,000 B.t.u.
California crude	18,000 to 19,800 B.t.u.
Burma crude	19,500 B.t.u.

His estimate of the available supply of oil shale is 5½ million tons.

J. Andrew Wauchope, reporting on the northern or Latrobe section, estimates six million tons of shale with a crude oil recovery of 240 million gallons. The yield per ton is approximately 40 imperial gallons. The government grants a bonus of $1.87 a ton on all shale mined.

The tasmanite beds average seven feet in thickness but, eliminating a middle barren stratum, there are four feet six inches of high grade oil shale. The sulphur content of the crude oil is low, 0.6 per cent. Government Geologist Twelvetrees, estimated that in the Mersey district there are 12 million tons of shale to yield two million tons of crude oil. The consumption of oil in Tasmania has increased from 18 million gallons in 1903 to 53 millions in 1920 and is increasing so steadily that there seems to be every reason to expect that the oil shale industry in Tasmania will soon be on a commercially profitable basis.

BURMA SIAM The oil shale deposits are in the valley of the Thaungyin river, the boundary between British Burma and Siam, so that they may be regarded as being in both Burma and Siam. The most promising part of the field is at Tichara, on a tributary of the Thaungyin river. The oil shales occur in basins of Pliocene age, and contain many fossils. The deposit is known to be extensive enough to yield millions of barrels of oil, of good quality and easy to refine. The remoteness of the deposit is its only drawback but British interests are developing it, putting down bore holes, testing the shale, experimenting on retorts, and contemplate the building of a railroad to the property.

ENGLAND AND SCOTLAND The excess of sulphur in the oil shale deposits of Norfolk county and of Dorsetshire still remain an obstacle to their commercial development. That it is a puzzling problem is freely admitted. The chemist who can solve it and devise a cheap, effective method of eliminating sulphur will be an economic savior to the British Isles. The industry in Scotland is continuing,

as it has for more than half a century, to mine, retort, refine, and market its oil shale products. The Somerset oil shales are being developed under the direction of John Berry but details are not yet available.

Annual reports in 1922 of three of the Scottish Oil Shale Companies, subsidiaries of the parent company the Scottish Oil, Ltd., give the following interesting financial results:

Broxburn
- Dividend ..... 7½ per cent
- Written off for depreciation $84,000.00
- Cash balance 63,290.00

Oakbank
- Dividend ..... 10 per cent
- Written off for depreciation $100,000.00
- Cash balance 151,860.00

Pumpherston
- Dividend ..... 10 per cent
- Written off for depreciation $100,000.00
- Cash balance 310,230.00

At the annual meeting of Scottish Oils, Ltd., March 31, 1922, a credit balance, after providing for depreciation, of $817,420.00 was reported. An interim dividend on the participating preference shares of 7 per cent was declared as well as a regular dividend of the same amount. This distribution left a cash balance of $91,395.00 to be carried forward. Sir Charles Greenway, Bart, President of the company, stated that the prospects of the company were more favorable than the year before.

In estimating sterling, $5.00 is taken for convenience as the value of the pound sterling.

In order to have data with which to make comparisons between the crude shale oil as produced in Scotland and the American shale oil, Prof. Arthur J. Franks, at the Colorado School of Mines, has made the following analysis of shale oil from the Broxburn works in Scotland.

Analysis of Scotch (Broxburn) shale oil. Specific gravity of the oil at 25°C was 0.864.

DATA FROM DISTILLATION AND ANALYSIS OF FRACTIONS

Percent Distilled	Temperatures Degrees C	Sp. Gravities at 25°C	Percentage Saturation
I. B. P.	85	.....	.....
5	173	0.775	68.4
10	196		
20	227	.806	65.0
30	261	.825	64.0
40	292	.846	60.0
50	314	.857	62.4
60	344	.867	60.0
70	360	.870	58.0
80	365	.833	58.0
90	362	.878	56.0
96.6	.....	.880	53.0

Method of analysis: Standard method described in Chem. Met. 24, 561.

Amounts of unrefined, commercial products on the basis of the above analysis.

- Gasoline (225°C. End Point) ..... 18.0 per cent
- Illuminating oils ..... 27.0 per cent
- Gas and fuel oils ..... 20.0 per cent
- Lubricating oils and wax ..... 31.0 per cent
- To coke and gas ..... 4.0 per cent

Total - - - 100.0

The new types of retorts projected in England are the L. M. N. or Nielsen process, the Plauson, Turner, Lamplough-Harper, Fusion, White, Freeman, Ironsides, and the Hampton-Ryan digestion process. In the Hampton-Ryan process a distinguishing feature is the keeping of the temperature below 360°F and producing vapors rather than permanent gases. Gasoline and kerosene are said to be derived, condensed, and refined in virtually one operation. The Plauson is a colloidal process, invented by an Esthonian, and developed in Hanover, Germany. A retort is now being erected in Esthonia by a French Company. T. G. Ironsides has invented a low temperature retort of the vertical type fitted with stirrers and divided into horizontal sections in which the powdered shale is preheated until it is just ready to give off vapors. It is then mixed with hot sand and the temperature of the shale raised to the point needed for complete carbonization under low temperature conditions while the sand is a little hotter and there is still sufficient heat present to distill the volatiles. Experimental work has been done in South Africa.

The Turner retort represents the vertical, internal heated retort with the use of steam. It has been under test on a commercial scale on the property of English Oilfields, Ltd., in Norfolk County.

In the Freeman Multiple retort the striking feature is heat control. The British Oil & Fuel Conservation, Ltd., of London, has equipped a testing laboratory at Willesden, has installed a Freeman Multiple Low Temperature retort, and is prepared to make 10 ton tests on oil shale and similar carbonaceous material. For this retort the shale is reduced to a very fine mesh. Throughout the entire treatment the heat is carefully controlled by a precision temperature system, so that excessive heating is avoided and a scientific and economic treatment of the shale results.

The Lamplough-Harper retort is of the vertical type and is noteworthy because of the claims made by the inventors, i. e. a low percentage of unsaturates, no gas, and a clean crude oil. The shale is treated by indirect heat. A formal test was made Oct. 17 at Feltham, near London. A yield of 49.4 gallons to the ton was obtained on oil shale from the Transvaal. A small test plant is to be erected in South Africa.

Dr. Carter White has devised a horizontal, revolving retort which has been erected at Vikhroli near Bombay, which, the inventor claims, has new and important features. The Petroleum Times, London, says of this retort.

"The heated gas is circulated through the retort a number of times before extraction and water for condensers is practically dispensed with. The gas, upon leaving the retort, is passed through a mechanical extractor, which precipitates the heavy oil and is then circulated by means of a blower or fan again through the retort, being reheated on its way to a furnace, and so on until the gas is saturated with oil, which can be accomplished without extensive cracking taking place. It is then cooled to a temperature of about 70° F. and compressed in a two-stage compressor, the rich gas readily giving up its oil and afterwards being reheated and circulated through the retort again until sufficiently enriched to be compressed."

The Fusion retort is of the revolving, horizontal, externally heated type fitted with a revolving breaker which breaks the shale while in transit. The corporation has erected an experimental plant at Middlewich to work in three ways : a. to treat shale in lots up to half a pound; b. in lots up to five pounds; and c. a five ton unit. This is 25 feet long and ten feet six inches in diameter. The feed and discharge are both

continuous and automatic. Considerable experimental work has been done on a great variety of shales. The following are typical:

	Esthonian Shale	Nova Scotia Torbanite	Australia Torbanite	Kimmeridge Shale
Yield of oil in gal.	73.60	51.80	131.7	52.50
Gravity	0.921	0.849	0.854	0.980

An English authority says: "I have been immensely impressed with the Fusion Corporations type as being simple, strong, cheap, and able to fulfil all requirements, thus largely increasing the output from certain known shales and enabling us to deal with the very richest types."

Retorts may be classified roughly into two main groups according to the method of heat application. The first method is that of external heat application in much the same manner as practiced in gas works. The second method is the use of the sensible heat of inert re-action gases; that is, gases that do not contain any free oxygen as such. These gases are brought into direct contact with the shale. Thus the retort, since it acts only as a container, may theoretically be either vertical or horizontal. The L. M. N., or Nielsen, retort is a pronounced example of the second and horizontal type. It is the result of long study and extensive experimental work by Harald Nielsen, a Danish engineer of long experience and a close student of low temperature carbonization. An experimental plant has been installed at Chatterley. A 100-ton retort erected in India is reported to be a pronounced success.

E. H. Cunningham-Craig, of London, a man of world wide experience and an international authority, at the International Conference on Fuel Oil in Paris October, 1922, summarized the situation as follows:

"Today, however, constant scientific research in retorting, largely due to our necessities in the late war, has so greatly advanced that it is high time that commercial attention should be called to the resulting possibilities of shales and torbanites, and capitalists should realize that with that advance, coupled with the wasteful expenditure in drilling unremunerative wells in depleting oilfields, it may well be, indeed is, probable, that the exploitation of the shales and torbanites will provide almost as great, and probably more certain, returns than are to be obtained from oilfields, especially where they do not come into actual competition. Let them also realize that in a report from Mexico, which I have but lately read, only one out of ten wells bored lately have struck oil at all. Taking the cost of each boring at some 20,000 pounds sterling ($100,000) that means a wholly unproductive expenditure of 180,000 pounds ($900,000). Such cannot occur with shales and torbanites. Here every shaft sunk must be productive and the remuneration almost wholly depends, in this case, on the economic efficiency of the methods employed, and but partially to the proximity of the markets. I am convinced that we are on the eve of a very great forward step in the development of shales in general and torbanites in particular."

JAPAN The oil shales of Japan are closely associated with the oil fields. They are termed "Marine Kerogen Shales" because of the large number of marine fossils found in them. To date, there has been no extensive development of the deposits but they have been studied chemically and geologically by Junichi Takahashi. They yield on the average somewhat less oil than shales in other countries but still they may become commercially profitable to Japan if her domestic supply of well oil diminishes to any great extent.

ESTHONIA An international survey of the oil shale industry indicates that the most noteworthy deposit and the greatest pioneering activity is to be found in Esthonia. This, with Letvia and Lithuania, form the three Baltic "buffer" states created by the Treaty of Versailles. Esthonia is the nearest to Petrograd, touches the Gulf of Finland on the north and the Baltic sea on the west. It has an area of only 4000 square miles, a population of 2,000,000, but it has a virtually unlimited

supply of oil shale. This deposit outcrops on the shore of the Gulf of Finland for a distance of 60 miles between Rakvere and Johvi. It dips slightly to the south, the overburden is slight, and the deposit is easily removed by steam shovels. The deposit is conservatively estimated to contain at least a billion and a half tons of easily workable shale, locally known as "Kukersite." Title to the oil shale deposits lies in the Government but in order to stimulate development, concessions are granted both to Esthonians and foreigners alike. The Carboil syndicate of London has a concession for 6000 acres, another for 6250 acres. Still another British syndicate is negotiating for 40,000 acres. A Belgian syndicate has a concession for 25,000 acres and a right to lay a pipe line from Kohla to the Baltic sea. The organization of the Esthonian Oil Shale Joint Stock Co., of London, has also been effected to operate in Esthonia. The nominal capital is 28,000 pounds sterling. During the year, 3334 tons of shale were mined by the company for its experimental plants alone. A local corporation, the Northern Paper and Cellulose Co., controls a large area, and is putting up extensive equipment, building railways, and erecting dwellings preparatory to operating on a very large scale. In July, 1921, the first retort, on order of the Esthonian government, of a daily capacity of ten tons, was erected by the Julius Pintsch Aktiengesellschaft, Berlin. A full sized plant of the vertical, modified Scotch type is now being constructed to consist of six unit retorts of a daily throughput of 33 tons each, besides breaker, condenser, washing plant, refinery, and power plant. It is expected that the complete plant will be in operation in the summer of 1923.

I am indebted to the Secretary of the Esthonian Legation in London for the following information:

"In the course of the year there were issued altogether 14 permissions for the investigation of the oil shale fields, the total area under investigation being 316.5 square kilometers. As the result of these investigations four plots with the total area of 174.8 square kilometers were handed over to concessioners. Another result of the investigations was that a new area of about 400 square kilometers was added to the exploitable fields. Of the mines managed by the Government there were in operation two: Kohtla-Jarve mine, where the shale was worked by open cut, and Kukruse mine where it was worked under ground. The output of the former in the course of the year amounted to 122,210 tons and that of the latter 10,481.5 tons. The bulk of the excavated oil shale was used as fuel in cement and gas factories, also on engines and for the heating of boilers in general. Only a small quantity of the shale was used for distilling purposes by test retorts.

"Outside of Esthonia distillation tests upon the Esthonian oil shale were made in retorts of various types; in England—in Freeman's and Hutchinson's retorts; in Germany, in Thyssen's and others. Experiments had been carried out also in Sweden. Satisfactory results were obtained at fractional distillation tests upon oil by using the Plauson's colloid apparatus. Tests are now being made with the object of finding out the best methods of fractional distillation. The ash of the oil shale is being used for cement and for bricks with very good results."

E. H. Cunningham-Craig, of London, after a careful examination of this deposit says, "That it is the oldest oil shale in the world that is being worked, that it is the richest oil shale known, and that it occurs under such extraordinary simple conditions that by a study of it we may glean very definite information about the origin of oil shale."

P. N. Kogerman, of the University of Dorpat, conducted an extensive chemical examination of Esthonian oil shale at the Imperial College of Science and Technology at London. The results of one experiment on distillation gave 63.3, 72.9, 74.8, 65.0, and 49. imperial gallons to the ton. Another experiment gave 68.0, 71.5, 73.7, and 77.3 gallons. The shale, therefore, is very rich in its oil yield. His results are summarized as follows:

In spite of the great variation in ash content of kukersite the pure organic substance has nearly constant ultimate composition.

As shown by the action of solvents, the kukersite does not contain any free bitumen.

The largest yield of crude oil is obtained at a temperature of about 600° C.

The yield of ammonium sulphate is very low.

The crude tar may be used directly as a fuel.

All fractions (especially those with the higher boiling points) are oxidized on exposure to the air.

The composition of crude low temperature kukersite tar is not so simple as the earlier investigators assumed. It contains a great number of olefines and unsaturated cyclic hydrocarbons. The paraffin content is very low.

The usual methods adopted for the refining of crude petroleum are not applicable to the refining of crude oil from kukersite.

A sample of kukersite tested at the Colorado School of Mines by Prof. A. J. Franks gave the following:

Analysis of Kukersite

Oil yield:—63.5 gallons per ton. (Much gas was formed during carbonization).

Analysis of Oil

170 cc. sample taken for analysis. I. b. p. 66° C. Sp. Gr. 0.937 25°).

Per cent Distilled	Temp. C	Sp. Grav. at 25°	Per cent Saturation	Color after Distillation
5	135			
10	154	0.761	54.0	Slight yellow
20	207	.823	46.0	Light yellow
30	257	.876	38.6	Yellow
40	279	.928	28.3	Greenish brown
50	330	.966	13.0	Greenish brown drk.
60	348	.977	8.0	Dark
70	365	N.D.	9.5	Dark
80	345	.967	12.0	Dark
87	.....	N.D.	9.0	Dark

Coke:—6.3 per cent by weight.

In 1921, 5,785,751 poods or 104,143 tons of oil shale were mined. The output for 1922 will probably approach 200,000 tons. Much of this was used as raw fuel under boilers, in steamships, in locomotives, in cement works, lime kilns, at the Revel gas works, and for domestic purposes. When the production of oil and its products reaches a commercial stage of production, the use of kukersite as a raw fuel will probably cease and, with the production of crude oil far beyond her domestic needs, Esthonia will enter the international oil trade with great economic advantage to herself.

RUSSIA Oil shales are found chiefly in the Jurassic formations in middle and southern parts of the valley of the Volga River and east to the Ural Mountains. The most available deposits and, most important are found at Simfirsk, Sysrau, and Obshe Syrt. The available supply is estimated at 360,000,000 tons. Volatile matter varies from 20 to 33 per cent. The yield of oil averages 10 per cent. The Volga valley shales have been explored only during the past two years.

THE STATUS OF THE PETROLEUM INDUSTRY In the maze of reports of oil gushers, the market quotations on oil stocks, production statistics, the swing of prices for crude oil and gasoline, conflicting opinions on all phases of the subject, it is difficult to get a true estimate of the real underlying condition of the petroleum industry. Recourse must necessarily be had to the acknowledged lead-

ers. There can be no question of the standing and good judgment of A. C. Bedford, Chairman of the Board of Directors of the Standard Oil Co. of New Jersey. In his address "The American Point of View on the World Oil Situation," he said, "The war disclosed the extent to which modern civilization is dependent upon an adequate supply of petroleum. Events of recent years have made clear the fact that the normal expansion of oil production by no means provides assurance of continued adequate supply. The United States is the largest producer of petroleum among the nations. It is also overwhelmingly the largest consumer both in gross and per capita. In recent years the United States has very largely increased its domestic production, and yet, at the same time, has been importing an ever increasing quantity. Imports from Mexico, which in 1918 were nearly 39,000,000 barrels, amounted to more than 128,000,000 barrels in 1921, while for the first six months of 1922 the importations from Mexico were at the rate of 158,000,000 barrels per annum. The development of industry, the always increasing use of machinery and the gasoline engine, the opening up of the more backward parts of the world, coupled with the dependence mankind has come to feel upon fuel oil as a necessary support to its coal supply, has made it apparent that the problem of oil is no longer a question of finding markets; it is a problem of obtaining adequate supplies."

In his address before the American Petroleum Institute, St. Louis, Dec. 6, 1922, he said:

"With all this expansion the oil industry remains essentially a free industry. Its very nature prevents monopolization of group control. No man knows today where oil will be found tomorrow or in what quantity. No man or group of men can restrain another from seeking oil in the earth, nor, having found it, can they restrict or augment its flow. The expansion has come about, not through excessive profits, but because of the production and the application to a myriad of new uses of the petroleum deposits of this and other countries. Last year the United States supplied sixty-two per cent of the world's production of crude petroleum and by importing an additional seventeen per cent, principally from Mexico, it met not only the enormous domestic demand for refined products but it exported 2,425,000,000 gallons of refined mineral oils, 372,000,000 gallons of crude, and 226,000,000 pounds of paraffine wax, in addition to a vast amount of minor products. Approximately fifty-eight per cent of the world's requirement of mineral oils was provided by this industry. The industry has flourished because conditions of free competition have obtained, and because it has experienced a long period of almost uninterrupted and unexampled growth in the markets for petroleum products. No one can prophesy as to the cost of the crude oil supply of the future. A simple analysis of the domestic production of crude during the month of September furnishes an apt illustration of the fact that what would be an abnormality in any other business is normal in the petroleum industry. In that month there were approximately 275,000 oil wells in the United States, and they produced a daily average of 1,503,000 barrels of oil, or 5.46 barrels per well per day. However, slightly more than fifty per cent of this total production, that is to say 779,423 barrels of oil, was being produced from only 8,097 wells, or 2.58 per cent of the total number of oil wells in the United States. Furthermore, one-third of the production of the United States in September was coming from 2,795 wells or 1.02 per cent of the total number of oil wells."

CONCLUSION When will oil shale come into its own? When will shale oil be produced on a commercial basis? Those who declare that the time is a quarter of a century hence lack vision and cannot perceive the signs of the times. They do not realize that,

according to Dr. McKee of Columbia, the per capita consumption of petroleum in the United States in 1900, when automobiles became common, was 35 gallons; in 1910 this had risen to 96 gallons; in 1920 to 210 gallons; in 1921 to 231 gallons; and the end is not yet. Our industrial life depends more upon a liberal supply of oil than upon any other single item. Thirty-five years ago Indiana and Ohio were greatly excited over the discovery of gas. Every farmer had his gas well and at night the whole heavens were lighted by scores of wells burning freely. Warning that the supply of gas was limited went unheeded. For years natural gas in that section has been as extinct as the dodo. The uncertainty of the natural supply of mobile material like gas, water, and oil is proverbial. Prince or pauper, is well applied. The present regular daily production of oil at around 1,700,000 barrels seems to be the peak; a gradual decline may be expected, retarded only by the discovery of some new oil pool. The great underlying feature of our oil supply is its uncertainty. The best guess of the experts is that nine billion barrels of oil still remain in underground pools in the United States. This is but a small fraction, a mere drop as it were, compared with immense amount of oil known to be recoverable from the oil shales of California, Nevada, Utah, Wyoming, Colorado, Indiana, Ohio and Kentucky, to say nothing of deposits in other states. There are, however, many problems to be solved and obstacles to be removed. The General Land Office should indicate clearly just what will and what will not be accepted as valid assessment work, so that a locator may spend his time and money to the best advantage. The mere cutting of scars in a cliff, in a region already well prospected, is a useless expense yet it is accepted as valid work. The faker must be curbed. The fact that a little raw shale, a burner, and a test tube form the equipment by which the real oil and gas may be produced before the eyes of the uninformed, coupled with a statement of the vast extent of the oil shale deposits creates a wild desire to "get in." Cupidity, avarice, and ignorance do the rest. Although it is true that a great variety of by-products may be obtained from shale oil yet it must be realized that these are already supplied by the chemical manufacturing concerns, that the demand for them is limited and already supplied. To enter this field is hazardous. However, there are two large and insistent demands that need to be satisfied, for fuel oil and for gasoline. The untoward incidents in the coal industry make large coal consumers desire some other fuel. Crude oil would be adopted if a regular supply were assured. A common sense view of the situation suggests that in the first stages of the oil shale industry efforts should be directed to producing a good grade of oil; then by topping and cracking to get the largest possible production of gasoline for which there is a broad market. Finally, what is left should be sold as fuel oil for which there is also a good demand that will increase, if for no other reason than to dodge the dirt, inconvenience, high price, and troubles attendant upon the use of raw coal. The crux of the whole matter is the price which crude oil brings at the well. At present this is low, but just as soon as this price advances to the point where shale oil can be produced in competition with well oil then shale oil will be produced in commercial quantities, will compete with well oil, and supplement, but not supplant, well oil.

The United States produces two thirds of the world's supply of crude oil; she has a world market for all the oil and oil products she can produce; she has, in addition to her vast oil pools, a still vaster potential supply of oil in her oil shale deposits; she has resourceful and efficient chemists, engineers, mining men, business men, and financiers; when the economic condition has arrived for the exploitation, development, and financing of the oil shale industry in a large and comprehensive way the United States will not be found wanting.

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