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OUTLINES OF PROCESSING FOR KANSAS MINERALS

by

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OUTLINES OF PROCESSING FOR KANSAS MINERALS

The State Geological Survey of Kansas
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Nonmetallic Mineral Resources of Kansas

- Asphalt Rock
- Bentonite
- Chalk
- Chat
- "Clay"
- "Shale"
- Diatomaceous Marl
- Gypsum
- Limestone
- Rock Wool
- Salt
- Sand and Gravel
- Sandstone
- Tripoli
- Volcanic Ash
- References

Metals

- Aluminum from Kansas Clays
- Iron
- Magnesium
- Lead and Zinc
- References

Fuels of Kansas

- Coal
- Petroleum

The following pages contain a brief summary description of the basic procedures involved in the production and processing of Kansas mineral resources. Descriptions of processing methods and plants are quite brief but care has been taken to mention the stages in processing where transportation - particularly transportation by rail - commonly or necessarily occurs.

Several of the materials discussed in this report are not now produced on a commercial basis in the state. These have been included here since, as in the case of some, transportation costs may be the factor controlling the practicability of commercial production.

Attention is called to several publications of the State Geological Survey which contain specific data concerning the occurrence, quality and reserves of Kansas minerals: Bulletin 41, pt. 3, "Kansas Mineral Resources for Wartime Industries"; Bulletin 41, pt. 4 , "Map of the Mineral Resources of Kansas"; and "Resource-Full Kansas."

NONMETALLIC MINERAL RESOURCES OF KANSAS

Asphalt Rock

Asphalt rock is mined by open quarrying or tunneling. The asphalt impregnated rock, usually sandstone or limestone, is loaded into open gondola cars and hauled to the crusher. Crushing and pulverizing reduces the large blocks of asphalt rock to a suitable road surfacing material. If the asphalt content is low it may be necessary to enrich the mixture by adding artificial asphalt. The surfacing mixture is then loaded into open top gondola cars and shipped to local markets. Occassionally the crushed asphalt rock is shipped in sacks containing from 150 to 200 pounds each. At the destination it is unloaded by steam shovels or pick and shovel into highway construction trucks, which then spread it onto the highways.

Asphalt rock has been produced only in Linn county, although asphalt and oil seeps have been reported in other counties of southeastern Kansas.

The most common use of rock asphalt is as an asphalt surfacing material for roads, airport runways, and sidewalks, etc.

Bentonite

Bentonite, a sedimentary rock, is mined by stripping and drift or slope mining. The bentonite in many deposits is soft and can be loosened by plowing, while in other deposits it is so hard that the rock must be blasted loose. The bentonite is first spread and allowed to dry for several days in order to remove the moisture which it may contain. The dried bentonite is loaded by hand or by power shovels into trucks or freight cars. It may be marketed without being refined or sent to a mill to be processed. At the mill the lumps of bentonite are heated, and partly disintegrate during this drying process. The dry bentonite is next screened to remove impurities and sent thru the disintegrators. This finely powdered bentonite is mixed with water, kneaded, and passed through an extrusion machine. The long strings of plastic bentonite come from this machine and fall on a moving belt which carries them through a steam dryer. The dried product is pulverized, screened and baked in a rotary kiln. The baked material is rehydrated in large steel vats heated by steam coils. After washing and screening the processed bentonite is packed into barrels or storage vats. Bentonite is refined at Ardmore, South Dakota, by the Refinite Co., at Los Angeles, California, and at Chicago, Illinois.

The known deposits of bentonite in Kansas are in Phillips and Wallace counties.

Bentonite is used as a water softener and drilling mud, in its raw state,

as a purifier in oil refineries, a filler in high-grade papers, a de-inking agent, beauty clays, a lathering and detergenting agent in soaps, a filler for rubber, a constituent in paints, and bonding clay in electrical and chemical porcelain, in abrasive wheels, and in graphite crucibles.

Chalk

Chalk is recovered by open cut quarrying. This raw material is then loaded into open gondola cars and shipped to Joplin, Missouri, to be processed. Of the two methods of grinding chalk, the wet method is more widely used than the dry. In the dry-grinding method, the raw chalk is passed first through jaw or gyratory crushers. This crushed chalk is then sent through a Raymond roller mill, tube, emery or similar fine grinding machine. The grindings are sized by air separation and the coarse material is returned to the mill to be reground. The fine sizes are bagged for shipment. Wet grinding usually involves the following operations: crushing, grinding, water classifying, filtering, drying, disintegrating the dried product, and packing it for shipment. True chalk whiting may be sized or classified by settling and filtering. The sized chalk is pressed into cakes before it is dried in order to remove most of the water. These cakes are then dehydrated in low temperature kilns. The dried cakes are crushed and the finely powdered chalk is packed for distribution.

Cretaceous chalk beds crop out in Ellis, Graham, Gove, Logan, Norton, Osborne, Phillips, Smith and Trego counties.

The finished product from these refining processes may be used as a rubber filler, paint whiting, a base in putty, glazing compounds, abrasives and polishes, a base in picture moldings, facings for molds and cores used in brass foundries

a white shoe dressing, a coating for glazed paper, an enamel base, a constituent in insulating compounds, a filler in linoleum, oilcloth, roofing cement, calcimine and other cold water paints. It is also used in structural iron work, shipbuilding, locomotive shops, and in the manufacturing of explosives, leather and fiber goods.

Chat

Chat constitutes the rock waste with which the lead and zinc minerals are associated and is a by-product of the mining of lead and zinc ore in the Tri-state mining district. Great quantities of chat are available in this area. The chief use of chat is as a road surfacing material. Most of it is concentrated in the Tri-state district and must be hauled by truck or open gondola cars to distant points in Kansas and neighboring states. All crushed rock is subject to the same set of transportation conditions as chat.

"Clay"

"Clay" is a term used in this report to designate clay stones or clay shales composed almost entirely of the mineral kaolinite. The kaolinite "clay" deposits of western Kansas have not been extensively exploited. Only about four and one-half carloads of "clay" have been taken from the deposits in that part of the state; although, kaolinitic underclays have been used in southeastern Kansas for many years (these underclays are treated by the methods described for "shales".) The former deposits are far removed from the processing plants, and freight rates have kept them from being utilized. The "clay" is recovered from open pit quarries by steam shovels or shale scrapers. It is loaded into trucks and hauled to the nearest rail point. From there it is shipped to the processing plant. The "clay" should be shipped in closed or covered cars in order to protect it from the rains. It is ground by pan mills and screened to a certain size before it is used. This finely divided "clay" is mixed with water, kneaded, and sent into the extrusion machine. It may be placed in bags at this stage and shipped by closed freight cars to other areas where it is made into bricks and pottery, etc. Such products as bricks and tile may be molded into final form by the orifice through which they are extruded. In the case of molded or irregular shaped tiling, the plastic "clay" is taken from the extrusion machine as bars and forced into

molds where it is given the desired shape. The molded product from the extrusion machine is dried in low temperature ovens.

The "green" clay objects to be fired are often coated or painted with a feldspathoid or volcanic ash glazing compound and fired in high temperature kilns. Salt glazing is accomplished by placing the "green" object in the kiln, and tossing a handful of salt into the open door of the kiln while the brick is being fired.

When pottery is to be made, the clay is mined, ground, graded by screening, mixed with water and kneaded. The plastic "clay" is then worked by hand into pottery and artware.

The chief uses of Kansas clays are: in the manufacturing of refractory fire brick and blocks, chemical porcelain, porcelain, electrical supplies, low heat duty refractory blocks, pottery, building blocks, high grade tile, sanitary ware, as sources of alumina, as fillers of various kinds, and as linings for foundry work. There is an increasing use of white kaolinite "clay" as a filler in many plastic compounds. This is an important use because many commodities require as much as 50% filler material. For this use the clay is mined and hauled by truck or closed railroad car to a mill where it is ground and sized by screening. Because it can be used as a filler for many different kinds of plastic materials this graded and sacked "clay" is shipped to all parts of the United States. Transportation must be by closed box cars.

Kansas "clay" could be satisfactorily used as a filler in the following commodities: insecticides, candies, paper, oil cloth, paints, terra cotta, asbestos, wads, Kalsomine crayons, fireworks, gypsum products, phonograph and disk records, picture molding, and many others.

"Shale"

The illite and kaolinitic-illite clay shales, which Kansas has in such abundance, are placed under the heading of "shale." They can not be used for the same purposes as the kaolinite "clay" because of differences in texture, contained impurities, and physical nature of the illite clay particles. The "shales" are mined by open quarry methods. The overburden is stripped off, and the "shale" is removed by machine shovels or shale "side-wall" scrapers. Occasionally a drag line may be used. Commonly, the "shale" is loaded onto a conveyor belt on into a tram which unloads directly into the hopper of the grinder at the mill. Nearly all of the Kansas mills are located at the quarries. The "shale" is ground and graded to size. It is mixed and prepared for firing just as in the case of "clay." Glazing may take place during or after firing. Kansas has volcanic ash, salt, and quartz silts in the Upper Dakota formation, which are used as essential constituents in many glazing compounds.

The principal "shlae" processing plants of Kansas are located at Coffeyville, Fredonia, Weir, Buffalo, Salina, Humbolt, and Iola. They obtain the "shale" from local quarries.

"Shale" is an important constituent in the following articles: terra-cotta, toy brick, sewer pipe, drain and hollow tile, conduits, clay mortar, cement, red and brown earthenware, stoneware, and pottery.

Diatomaceous Marl

The enormous reserve of diatomaceous marl in Kansas is unexploited and undeveloped. Stripping by the use of power shovels, draglines, scrapers, or hand operations would be the most economical method of mining. Ordinarily the raw material is processed as near the deposit as possible in order that transportation costs are kept at a minimum. Diatomite is spread under the sun to dry before it is placed in the grizzlies. The ore drops through the sizing bars of the grizzly into a primary (coarse) crusher. The impurities are removed by sand, trash or magnetic separators, and the cleaned diatomite is passed through a secondary (fine) crushing machine where it is crushed wet. The material is washed and dried in low temperature kilns. This powder is packed in bags for shipment or it may be treated with heat and chemicals before it is classified and shacked for shipment.

Diatomaceous marl deposits have been reported in Wallace, Logan, Marshall, Meade, and Seward counties. Although Kansas diatomite has not been used to any great extent, that from other areas has been used in a great many different ways. A few of the most important uses are: as a filter for organic compounds, as a constituent in many types of insulating materials, fillers for various commodities, in the manufacturing of glass and soluble silicates, as an oil decolorizing agent, as a base in enamels, as an admixture for cements, mortars, puzzolan cements, and as a constituent in light weight building blocks and pannels. (See Mudd, p. 257)

Gypsum

There is such a variation in kinds, occurrence, and methods of production that it is very difficult to describe any process which can be regarded as standard for gypsum. The mines now operating in Marshall and Barber counties are large underground mines in which mining is by the room and pillar method. The ore is carried to the surface in hand, mule, or motor-powered cars having capacities of from two to five tons each. The ore is ordinarily hauled directly to the mill in open gondola cars, but it may be sent, instead, to brewers, plate-glass companies, and manufacturers of gypsum, etc. At the mill the bulk gypsum is crushed by jaw or gyratory crushers. The foreigh material and the iron is removed during the grinding process. The crushed gypsum which is used as a retarder in the manufacturing of cements, is obtained by this crushing process. The gypsum to be used thusly is shipped in open gondola or box cars. The material to be used in making plaster is dried to remove superficial moisture and is then ground to a powder. This raw ground gypsum may be sacked for use as a fertilizer, as alabaster for carvings, statuary and objects d'art, or Keen's cement. It is shipped to the manufacturers in closed freight cars. If the gypsum is to be made into a plastic compound it is sent on through the mill. The gypsum for plaster is calcined to remove the water of crystallization and scalpers remove all foreigh material before the powder goes into the finished product. At this stage the calcined gypsum is known as stucco. Stucco is shipped in 90 pound paper bags or by

bulk in closed railroad cars to the various places where plaster of paris commodities are manufactured. If it is to be used in wall-finishing the stucco is mixed with other ingredients at the mill, and the pigment and other raw materials are ground into the mixture. The wall finish, calcimine, is boxed in small cardboard or tin containers and shipped in box cars. That which is shipped to plate-glass companies, mixing mills, and cement manufacturers is used directly in their manufacturing processes. The stucco is used pure in sanded and neat goods. If it is to be used in finishing or molding plaster it is combined with a retarder, fiber and other ingredients. Some stucco is used in building blocks. The largest usage of plaster is in the making of wall board. The dry kilned wall board is shipped by closed box cars to be used for lathing and sheathing purposes.

The more important gypsum deposits of Kansas are in Marshall, Saline, Dickinson, McPherson, Marion, Comanche, Kiowa, and Barber counties. At present, there are gypsum processing plants at Medicine Lodge and Blue Rapids, Kansas. Because of the superior quality of gypsum mined in Kansas it is used to make only fine-grade plaster of paris. As yet, no attempt has been made to use the low-grade gypsum of Kansas in the making of plaster board, and wall board. This low-grade ore, "gypsite" is processed by the same methods as are used for the fine-grade gypsum.

Limestone

Limestone is mined by the open quarry method. To date, the available reserves have been such that no one has been forced to remove limestone by the room and pillar method. The large slabs shot loose by dynamiting are loaded into trucks by power shovels. The crude stone is taken directly to the gyratory crushers or loaded into open gondola cars. Occasionally, building stone may be cut from the quarry in massive blocks by giant quarry saws. It is cut into smaller sizes and surfaced by grinding before shipment as building block. The cut stone is transported by truck or railroad flat car. Crushed limestone is often shipped by open gondola car to fairly distant points to be used to enrichen soil in farming communities, or may be loaded into open trucks to be distributed at nearby farms for a similar purpose.

"Quick lime" is made by calcining the limestone after it has been coarsely ground. The calcine product, lump "lime", is crushed and agitated with water to produce a completely hydrated lime. This dry powder is then pulverized, the unburned "core" thrown out, and the remainder is air floated to clean it. This cleaned and sized hydrate is stored in bins to "age" before it is packed in cardboard or paper bags of various sizes. It is shipped to innumerable manufacturing centers because of its diversified usage.

Lime is used by paper mills, glass works, sugar factories, tanneries, and is used as refractories, for sanitation, in calcium carbide, sand-lime bricks, explosives, in metallurgical processing, rubber manufacturing, and in sewage-purification, etc.

When the limestone is to be used in cement it is ground and mixed with shale and blast-furnace slag. This is pulverized and poured into the cool top end of an inclined rotary kiln. As it rolls down it is fused and leaves the lower end as clinker. These clinkers are ground and a retarder, gypsum, is added. The product is ground and packed in 90 pound bags. It is transported in closed box cars.

There are unlimited amounts of excellent quality limestone deposits in eastern Kansas. The present limestone industry of the state is confined generally to Montgomery, Wilson, Neosho, Allen, and Wyandotte counties.

Kansas also has several argillaceous limestones which are of the type used to make natural or hydraulic cement. It is necessary only to crush and calcine these cement limestones to prepare the finished cement. There are no intermediate, arrested steps in production at which transportation by rail can be or is important.

Cement is used extensively in construction work, as structural and surfacing material.

Rock Wool

Rock wool is made from siliceous limestone or a mixture of limestone and siliceous rock (sandstone, and quartzite, etc.) The raw materials are mined by open quarry methods. The ore is blasted from the face and shoveled into trucks or mine cars. The rock wool is commonly manufactured near the mine. If the mill is located at the quarry the rock is loaded directly into the hopper of the grinder, but if the mill is some distance from the quarry the rock is hauldd to the mill hopper in trucks or open gondola railroad cars. The ore is crushed and screened. The screened rock, one-quarter of an inch in diameter, is placed in the hopper and melted. The molten rock is tapped at the bottom of the hopper and directed into a blast of steam or air. The blast causes the molten rock to be drawn out into thin strings which are blown to the opposite side of the room. The resultant rock wool is gathered from this room while it is still warm and processed into bats, felted down, or granulated by beating . The finished product is transported by closed box cars.

There are rock wool plants at Neodesha, Parsons, and Winfield, Kansas.

Salt

Rock salt is being mined by shaft mining at Lyons and Kanopolis, and supplying brine to plants at Hutchinson, Sterling, and Lyons, Kansas. In shaft mining the salt is removed by the room and pillar method. The rock salt is recovered by undercutting and blasting. It is loaded into mine cars and hauled to the surface. In most cases, the mills are near the mines. At the mill the rock salt is dumped into hoppers, which permit the coarse salt to be sorted into 5-, 3-, and 1-inch sizes, and send the large lumps to the store room. These large pieces are shipped for salting cattle in field and stable. They may also be put through hydraulic presses where they are molded into blocks weighing from 50 to 60 pounds. Sulphur, iodine, iron, other ingredients, and even coloring may be added to these blocks. These products and lump rock salt are shipped in bulk by closed box cars. The finer sizes of rock salt are crushed and graded to size by screening. The pure and clean salt is then boxed, or sacked and sent to the market in closed freight cars. Coarsely ground salt is often shipped in bulk by closed box cars for use in manufacturing dyes and dying, zeolite water treating, the glass industry, the making of iron and steel, paper, and pulp, rayon, in rendering plants, and in tanning, soap and tobacco manufacturing. Large quantities also are used in freezing and packing ice cream, to thaw ice and snow, as a weed exterminator, and in other ways.

Impure salt is dissolved in water and passed as a strong brine through the artificial evaporation process to be described under salt brines.

Salt brines.-- A second method of mining is carried on by sending steam, which dissolves the salt, to the salt-bearing stratum. The strong brine thus produced is forced to the surface and is passed through anartificial evaporation process by which the salt is recovered. Impurities such as hydrogen sulphide gas, iron compounds, calcium and magnesium salts are removed by chemical means if the salt is to be used by the food industries or for special purposes. Artificial evaporation may be accomplished by the use of direct fire or steam. The kettle process and the open-pan process are used in the case of direct fire evaporation.

The kettle method of steam evaporation utilizes a steam coil rather than a direct fire. "Grainer" salt is made in elongated shallow pans, heated by low-pressure steam coils. The salt, Halite, is then centrifuged until it contains 6 per cent moisture and dried in kilns. The salt produced is in flakey, thin flat grains. "Grainer" salt is used in butter and cheese making. It is sacked for shipment by closed box cars. Most of the granulated salt is made by a third steam evaporation, the vacuum pan process. The brine is evaporated in an evaporating unit evacuated to 28 inches and heated by low pressure steam coils. The brine is kept circulating in the evaporating cones throughout the process. Vacuum-pan salt is composed of fine,

type over

lustrous grains, and by virtue of its fineness and purity is particularly suitable for the table, for canning of foods, and in the manufacture of prepared flouss for cakes, pancakes and doughnuts, etc. It may also be used in dairy products. Table or "shaker" salt is screened to a thirty-mesh size and coated with about one per cent of non-hygroscopic substance such as magnesium or calcium carbonate. These fine grades of salt are packed in boxes of various sizes and shipped by closed freight cars.

Dry salt may be placed in the following classes, which do not correspond to those in the tariff act:

1. "Industrial" salt includes all salt, regardless of quality, sold for industrial uses and shipped in bulk, buyer's sacks, or producer's sacks, over 50 pounds in size.

2. "Domestic" salt includes all salt sold for domestic and household consumption, and shipped in units such as cartons and packages in sizes up to and including 50 pound bags and sacks, together with all barrels.

3. Pressed "blocks" in all sizes, but usually of from 50 to 60 pounds in weight.

The U. S. Tariff Commission recognizes the ten following producing areas.

1. Western central New York

2. Northern and central Ohio

3. Southern Ohio and nearby parts of West Virginia

4. Michigan (a) ~~Detroit~~ Detroit and vicinity, (b) Manistee and Ludington.

5. Central and southern Kansas and nearby parts of Oklahoma

6. Louisiana in the vicinity of Weeks, Avery and Jefferson Islands on the coastal waterway

7. Eastern Texas and Winnfield, Louisiana

8. Utah at Salt Lake and Redmond

9. California: San Francisco Bay area

10. California: Los Angeles, San Diego and Saltus

The bitterns recovered from the salt refining process quite often contain many other dissolved salts, but in so far as known Kansas rock salt is relatively pure. There are few, if any, other salts associated with them.

Salt is used very extensively in the manufacture of other sodium salts, such as soda ash, caustic soda, and so on, and in the making of chlorine and hydrochloric acid.

Phosgene, mustard and chlorine manufacturing concerns use large quantities of rock salt. For this use it is shipped as rock or crushed salt in closed box cars or canvas covered gondola cars.

Sand and gravel

The sand and gravel supply of Kansas is unlimited, and is composed of all types of sand and gravel. Some gravel deposits are worked by power shovels which feed directly into the cleaning and screening machines. In such machines the gravel and sand is graded to size by screening and may also be washed. Other gravel deposits are worked by hydraulic pumps in pits dug to below the water table. There is wide use for nearly all sizes of gravels but the "pea" gravel is most used. It is used in road surfacing, as shot-loading material for shooting oil wells, in cement work and innumerable such uses. It is transported by truck or by open top gondola railroad cars, and certain gravels to be used for specific purposes may be shipped long distances.

Sand may be obtained along with the gravel but much of it comes from the beds of our larger streams or sand deposits near rivers. The sand may be removed from the river bed deposits by dredging, the use of drag lines, or scrapers. This sand may either be loaded wet into open gondola cars or sent through a washing plant before loading.

The most important uses of sand are: as glass sand, if the sand is free of impurities and possesses certain desirable characteristics, as filter sand, in filtration plants which purify drinking water, as molding sand, building sand, as grinding and polishing sand, paving sand, blast sand, and other kinds.

Sandstone

A very hard light gray sandstone is quarried in Bourbon county, Kansas, for use as building stone. It is shipped on open flat cars to distant points in Illinois, Missouri, Kansas, Oklahoma, and Texas.

Tripoli

No tripoli rock is now being mined in Kansas although deposits are known to occur. Tripoli is mined by the open cut method. The large fragments are sledged to small sizes, and the waste material is removed. After it is graded according to color the "green" rock is hauled to drying sheds by trucks. Recently some of the tripoli has been dried by mechanical driers. The dry ore is crushed and fed through a hammer mill. This pulverized material is subjected to a schedule of alternate grinding and screening in which the ground tripoli is graded to size. The graded product is bagged for marketing. A processing plant at Baxter Springs, Kansas produces only a powder ground to pass through a 300-mesh screen or smaller. This processed tripoli is shipped to Detroit and other automobile manufacturing centers where it is used as a body polish. It is used locally in drilling muds.

Volcanic ash

Kansas is the leading state in the production of volcanic ash (pumice or pumicite). It is mined only by "stripping" or open cut methods. Ash is carried by wagons or trucks to the processing plant. It is properly dried to remove the excess moisture and graded to size by screening. Heavy impurities are removed by an air-blast cleaning operation. Milled ash is shipped loose in paper-lined box cars, or in 40 pound paper or 100 pound burlap bags.

"Pumicite" is used as an abrasive compound for grinding, polishing, and cleaning surfaces. Old Dutch Cleanser and other scouring powders, tooth paste, high-grade silver polishes, hand soaps, sweeping compounds, rubber erasers, insulating materials, paint fillers, and filtering agents are made of volcanic ash.

There is a great reserve of volcanic ash in Kansas. At present, volcanic ash is being produced in Comanche, Grant, Meade, Norton, Osborne, and Sheridan counties. The greater part of the ash recovered in these counties is shipped out of the state. The ash is crushed and screened to remove impurities near the quarry, but is sent to processing plants in Illinois, Michigan and Kansas.

Puzzolan and Tufa cements are made from volcanic ash and are unusually expensive in many areas because of high freight rates. These cements are made by mixing two parts of pulverized volcanic ash with one part of slacked lime. The two commodities do not occur together so manufacturing of this soft and slow settling cement necessitates shipping one or the other of these commodities by closed freight cars to the cement plant.

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METALS

Aluminum from Kansas Clays

The kaolinite "clays" of Kansas contain an average of from 25 to 35 percent alumina (Al_2O_3). Alumina has been reduced from the "clays" in the ceramic laboratories at the University of Kansas. Although the processes used are still in the experimental stages, there is promise that this method will allow exploitation of new and vast resources of aluminum.

"Clays", dug for processing, can best be mined by the open cut method. They can be enriched by sedimentation, and then precalcined by heating in a low temperature rotary kiln. There should be a pre-calcining unit at each mine, in order to reduce the bulk of one to be handled as much as possible. These units should have rail communication with an alumina reducing plant to be located centrally with respect to the mines themselves. The clay would be shipped after pre-calcining to the central plant. There the calcined clay would be reduced by the Kalunite process to alumina.

If alumina is produced in Kansas, power conditions in here may force the producers to send the alumina to out-of-state electrolytic plants. Those near by are the Reynolds Metal Company of America, Alcoa, Tennessee; and government owned plants at Massina, New York,

and Malvern, Arkansas. The alumina is shipped in closed or covered railroad cars to protect the cargo from rain. The uses of alumina are well known and quite varied.

Clays which can be refined for aluminum crop out in north-central, central and southwestern Kansas.

Iron

Professor E. D. Kinney has discussed iron hydroxide resulting from the purification of mine waters of the Tri-State area (Kinney, 1941). It is very probable that such processing will be used in the near future. Iron from this source might replace the pyrite cinders now used in the cement industry of southeastern Kansas. Transportation of the iron hydroxide to the nearby cement plants would probably be by motor tnuck.

The present source of iron used in the Kansas cement industries is pyrite obtained from coal by the washing and screening process. Approximately 10 pounds of pyrite are recovered from each ton of coal washed and screened. The impurities are run through a flotation process to concentrate the pyrite after which it is sent to St. Louis. A chemical plant at St. Louis recovers the sulphur by roasting the pyrite. The sulphur is used to make sulphuric acid and the pyrite cinders are shipped by open gondola cars to the cement manufacturing plants in southeastern Kansas.

The Cretaceous rocks of Russell County contain a layer of hematite and limonite 8 feet thick, a potential source of iron for chemical purposes and use in the cement industry.

MAGNESIUM

Magnesium contained in oil field brine and dolomite in Kansas is a potential source for this mineral. The dolomites cropping out in Rice, Reno, Kingman, Harper, and Clark counties could be slaked and used to treat magnesium bearing brines, thus producing magnesium hydroxide. The hydroxide is converted to the oxide by heating. Magnesium oxide could be shipped by bulk in paper lined box cars from the prospective producing plants in Kansas to electrolytic refining plants at Boulder dam, Freeport, Texas, or Midland, Michigan. At these plants magnesium oxide is treated with hydrochloric acid to produce magnesium chloride. This product is then subjected to electrolysis and pure magnesium is obtained.

Magnesium is used as a dioxidizing and disulphurizing agent in the manufacture of metals and alloys. Magnesium alloys are extensively used in aircraft parts, which include crank cases, pistons, oil pans, bearings and control levers, etc., because of their great strength and light weight. Magnesium is also used in tracer bullets, tracer shells, and incendiary bombs, and in flash-light powders, photographic flares, and other articles useful and essential in modern warfare and industry. Refractory bricks are often made of chromite or olivine and magnesite (Kansas has no magnesite).

LEAD AND ZINC

Lead and zinc deposits occur in the southeastern corner of Kansas. As all of the available surface deposits have been exhausted, mining has been extended as much as 450 feet underground. As a result of extensive mining, much of the underground in the area is filled with large labyrinthic chambers from which the ore has been taken. The ore is hoisted to the surface and taken by trucks or open gondola cars to the mills or concentrating plants. The ore is crushed and the lead and zinc are separated from the valueless gangue by the oil flotation or gravity process. The concentrates are sent to retort smelters in Oklahoma, Arkansas, Illinois, West Virginia, and Pennsylvania. Because of the depletion of favorably situated gas fields and as a reult of unfavorable freight rates, zinc smelting in the state has nearly ceased.

Zinc is used extensively in brass, galvanizing compounds, die castings, battery cans, photographic supplies, and paints, etc. Lead is used in storage batteries, insulators, ammunition, solder, bearing metal, and type metal, etc.

METALS

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FUELS OF KANSAS

Coal

Kansas coals have been mined by the following methods: strip or open cut mining, drift or slope mining, and shaft mining. In small scale operations, an attempt is made to take only that part of the coal bed which is marketable, thereby relieving the producer of the expense of a washing and cleaning operation or of having the coal hand sorted. The small mine cars are loaded and brought to the surface. These loaded cars are emptied directly into the trucks which come for the coal. The coal commonly goes by truck to local users. The State mine at Lansing, Kansas, is the only shaft coal mine in the state operating on a large scale. All of the coal produced by this mine is consumed at the prison.

Strip mining is most extensively used. The overburden, which ranges in thickness from 10 to 50 feet, is removed by huge power shovels or drag lines. Smaller shovels follow the huge strippers and scoop up the coal. Smaller operators may use one shovel for both operations. The coal is loaded directly into trucks or open railroad cars, which haul the coal to the processing plant, usually not far removed from the mining area. At the processing or cleaning plant the coal is crushed to release the impurities. It is thhn mixed with a heavy mud, composed of water and fine clay. The differential in specific gravities causes the

coal to float in the washing cones while the heavier impurities, ash-making material and iron pyrite, settle to the bottom of the cones from which they are removed. Pyrite is sent to the chemical plant at Mineral, Kansas, or some similar plant where it is used to make sulphuric acid. The coal is rinsed, dried, and graded to size by screening. There are many different sizes, each having a specific use. These grades of coal are then loaded in open top gondola cars for shipment.

Until recently it had been the habit of the coal producers to obtain as many empty coal cars as possible from the railroad companies. This was done in order that they might fill the cars and leave them on the sidings to ship the moment an order was received. It is not economically possible to store the coal in bins, then reload it for shipment. The coal must be loaded as it is brought to the surface. Recent discussions with the coal retailers of northeastern Kansas indicated that new railroad legislation does not permit the producers to get more cars than are necessary to fill standing orders. Should unexpected cold spells develop during the war winters ahead, the time necessary to order coal cars, obtain, fill and ship them may cause considerable delay in getting coal to areas needing fuel for home heating purposes.

Attempts to coke Kansas coal have not been successful. However, all coal except lignite and anthracite may be called coking coal. Although good coking coal may coke readily under certain conditions, they often act indifferent under other conditions. This fact causes one to speculate as to the possibility of the eventual discovery of methods which will cause certain of our coals to coke. In addition to coke, methods of destructive distillation of coal produce the following by-products: tar, ammonia sulphate, ammonia liquor, sulphur, gas to be used as fuel, light crude oils, naphthalene, other similar volatile hydrocarbons, and B-methyl-1-3 butadiene, the hydrocarbon from which artificial rubber can be made. One may also recall that coal is the raw material from which innumerable synthetic materials have been made in the laboratory; namely, acetic acid, acetone, alcohols, carbon dioxide, cellulose ethylene, formaldehyde, glucose, nitric acid and phenol.

There has been no coking or making of synthetic materials from Kansas coals.

Petroleum

Kansas has rich oil reserves. Petroleum has been more exploited than any of the mineral resources of Kansas. The crude oil is brought to the surface through drill holes. These holes are bored by rotary or standard drilling equipment, or a combination of the two, to the petroleum-bearing stratum. The wells are cased with steel casing. At the surface, the casing opens into a pipeline leading to the storage tanks. The petroleum may be under such pressure at the bottom in the formation that it is forced up through the casing and through the pipeline into the storage tanks. Most often, however, it is pumped to the surface by bottom hole pumps and hence into the storage tanks.

Only a small part of the crude oil produced is carried by the railroads. Oil is pumped via branch pipelines into the main pipeline which carries "crude oil" to the nearest refinery or cracking plant. If the well is located at considerable distance from one of the main lines, it may be necessary to lay a pipeline to the main line or to a nearby railroad spur, and build a loading rack there. The "crude oil" is pumped into tank cars and shipped to a refinery.

Crude oil can be broken down into many different by-products or materials from which by-products are obtained. The processes by which this is accomplished

are many and diversified. The first step in petroleum refining is known as distillation, by which crude oil is separated into various cuts or fractions; hence the term fractionation. Heating crude oil with an increasing temperature causes the following fractions to separate from it: gasoline and naphtha, kerosene, gas oil (fuel), light lubricating distillate, medium distillate and a liquid residue which may be very heavy lubricating oil, asphalt or industrial fuel oil. Petroleum coke is made by charing this residue. When a maximum yield of gasoline is required a cracking process is used in which waste products are converted into gasoline. The distillation process is a continuous operation conducted on a large scale. This raw gasoline is transported to the refineries by pipelines or tank cars. At the refinery it is blended or polymerized to meet the specifications of the retailing companies. It is then shipped in a railroad tank car to the local distributing centers. From there it is distributed by tank trucks. Although kerosene is commonly contained in metal barrels or drums, it is often shipped in tank car lots. The demand for gas oils in rural districts, as in the case of kerosene, necessitates its being supplied in metal barrels or drums. These metal containers may be shipped in any kind of freight cars. The light and medium distillate fractions are put commonly in containers

of one pint, one quart, one gallon and five gallons capacity. These often are boxed in cartons of one dozen containers and are transported in box-cars. Light and medium distillates are known commonly as lubricating oils. Heavy lubricating oils and greases are handled in a variety of containers.

Large quantities of petroleum asphalt are used in the construction of asphaltic wearing surfaces for highways, as a "binder" for stone and sand in main roads as filling in the joints and cracks of bricks, stone block and concrete and asphalt macadam, in the production of saturated felts and shingles for roofing goods, paints, etc. There is such a great variety of containers for other petroleum by-products that they can not be readily investigated here.

Artificial asphalt used to enrich the crushed asphaltic rock may be obtained from two sources, mineral free asphalt deposits, dug by pick and shovel (Kansas has no deposits of this type), or the refining of petroleum. Asphalt may be obtained by various methods of refining; namely, sedimentation, dehydration, fractional distillation by direct fire, forced fire distillation with direct fire, steam distillation, inert gas distillation and air blowing. Although the most widely known use of asphalt is in the construction of roads, it is also used as an acid-proof liner for certain types of containers, as a

rust preventor on metal surfaces, to coat masonry as a base for paints, plasters, etc., as an insulating material, as a binder pitch in coal briquettes and innumerable such uses. Mineral free asphalt is shipped commonly in specially constructed cars which contain heating units. Asphalt can be handled easier if it is kept in a fluid state. The most common types of containers are tank cars having a capacity of either 6,500, 8,000 or 10,000 gallons, tank trucks of lesser capacity, metal drums containing from 50 to 55 gallons---weighing from 475 to 526 pounds, wooden and fiber barrels of equal capacity, and it may be shipped in the form of molded blocks of asphalt.

Cracking of petroleum yields large quantities of butadiene, which is the polymerisable hydrocarbon used as a source of synthetic rubber. This butadiene is in a dilute form and must be separated before it can be used. Butadiene is transported by special tank cars. Synthetic rubber polymerisations are as yet subject only to empirical methods of control and are very ramified processes. The product resulting from polymerization, nioprene or allied compounds, must be kept cool in order to obviate tendency to polymerize or vulcanize to the elastic state before it is completely processed. Therefore, if it is to be transported at this stage of processing, it can be only by special means of conveyance. The finished rubber goods are carried in closed box cars.

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