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MINERAL PRODUCTS AND MISSOURI RIVER NAVIGATION IN SOUTH DAKOTA

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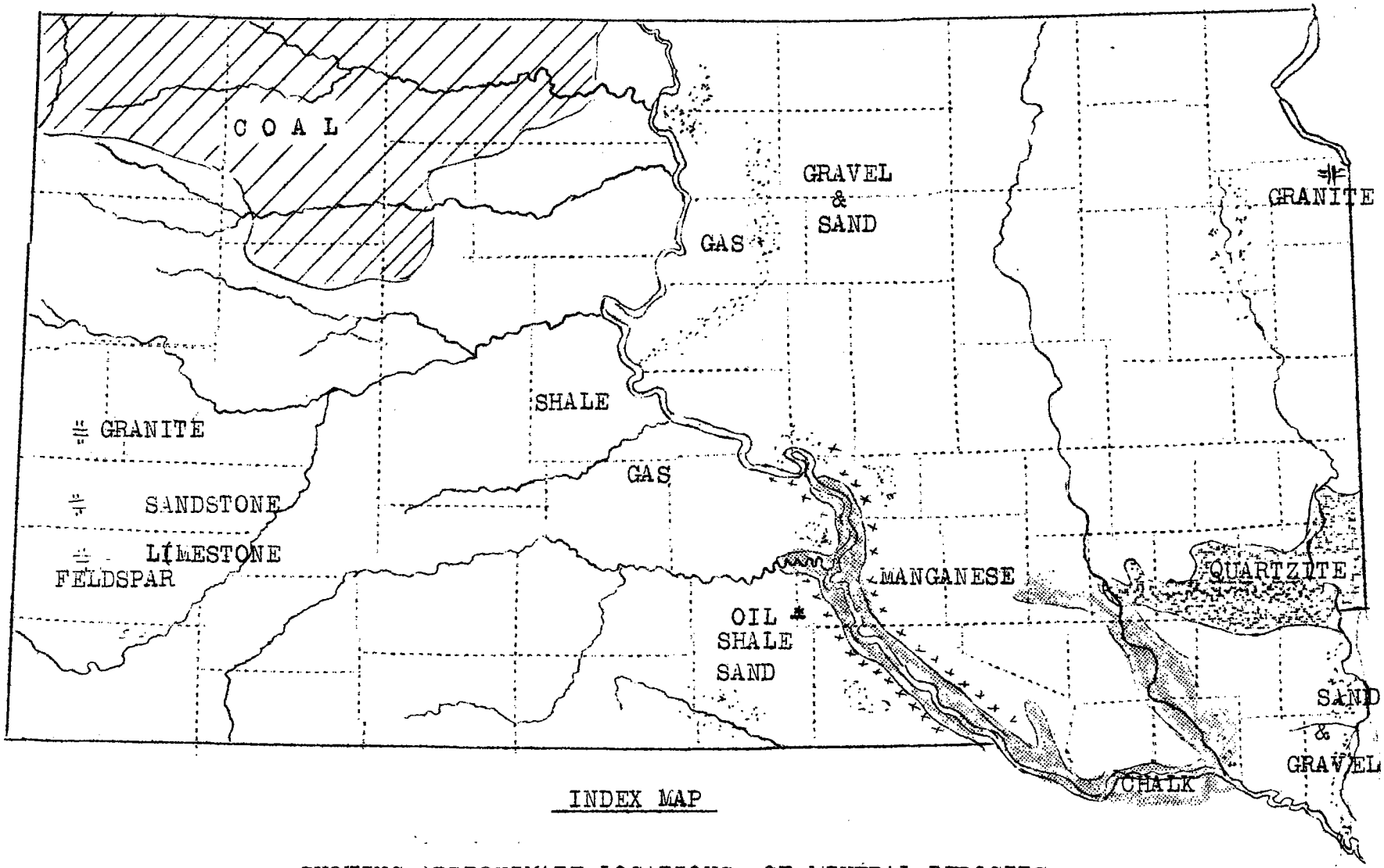

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SHOWING APPROXIMATE LOCATIONS OF MINERAL DEPOSITS

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MINERAL PRODUCTS AND MISSOURI RIVER NAVIGATION IN SOUTH DAKOTA

INTRODUCTION

The development of Missouri river navigation depending as it does on the possibility of developing freight which can be carried on the river has turned the attention to those interested in navigation to the possibility of carrying mineral products. These products being by nature heavy, bulky, and imperishable commodities, lend themselves readily to such transportation better than do most farm products.

Unfortunately, no large mineral business which could immediately turn its freight into river boats has been developed along the Missouri. Any business resulting from the exploitation of these mineral products, therefore, will have to be developed as a result of river navigation. The purpose of the following outline is to present those resources which might be transported to market by water if such transportation existed and if sufficient commercial ingenuity were found in the state to develop a demand for them.

METALS

Aluminum

Claims have been made in certain quarters that a source of metallic aluminum lay in the Missouri valley. They originated apparently from the chance remark of an engineer to the effect that the shales forming the Missouri bluffs contain 25% aluminum. Though this statement is true, it must be kept in mind that aluminum from shales and clay is not yet commercially feasible and the large volume of the known deposits of bauxite, the mineral now used as aluminum ore, does not look favorable for an early development of a commercial process for its extraction from shale.

Aluminum from shale will probably come in the future, but it will not be a valid argument for river development for many years to come.

Manganese

The deposits of sedimentary manganese in the Missouri bluffs between the Big Bend and Springfield and centering about Chamberlain have attracted considerable attention since their discovery in 1928. This ore is easily accessible to the Missouri River and could be loaded for shipment directly from the pits or with a very short haul. It therefore deserves further consideration in any program of river development. The following information is quoted from a report on these deposits made

by D. F. Hewett for the U. S. Geological Survey.[1]

> The Missouri River has cut a valley about 400 feet deep and several miles wide through the flat upland... The zone of manganiferous nodules forms a conspicuous dark band about 150 feet above the river, and this outcrop may be readily traced around the hills and ridges near it, as well as along the valley of the White River, which enters from the west.
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> ...a preliminary examination of the central part of the area was made by D. F. Hewett, a geologist of the Geological Survey, Department of the Interior, in July, 1929. The explorations adequately demonstrate the existence over many square miles of a horizontal bed 38 feet thick, which will give an average yield per cubic yard of 164 pounds of nodules having a manganese content of about 25 pounds. The explorations also indicate that a part of this bed 10 feet thick, or 26 percent of the total thickness, contains 36 percent of the manganese. In a part of the area the nodules of this 10-foot zone contain manganese to the extent of about 40 pounds per cubic yard of the inclosing shale. Obviously the aggregate quantity of manganese in the region is very large. As the grade of the material, expressed in pounds of manganese per cubic yard of shale, is much lower than any thus far worked on a commercial scale either in the United States or elsewhere, it remains to be seen whether the deposit can be treated profitably at present prices.
>
> ...the total quantity is estimated to be about 100,000,000 tons. The manganese content of the concretions in the entire bed in these nine townships probably averages about 25 pounds per cubic yard of shale, which, if converted to a high-grade product fit for smelting to ferromanganese, would be worth at present prices about 60 cents (2.4 cents per pound of manganese). The data indicate, however, that the richest 10-foot zone, 26 percent of the total volume, contains about 36,000,000 tons, or about 36 percent of the manganese..... Most of this material lies within 4 miles of the railroad. In this area the average manganese content is about 40 pounds per cubic yard of shale, and at present prices it would be worth about 96 cents per cubic yard. As this sum must cover cost of mining, separation of modules from shale, chemical recovery of the manganese, and transportation

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1. Manganese-Iron Carbonate Near Chamberlain, South Dakota, Press Notice, U.S. Geol. Survey, Feb. 5, 1930.

to the smelter, it is not yet certain whether this material can be worked so as to yield a profit at prevailing prices. In view of the unusual character of this material and the lack of demonstrated methods of treatment it does not seem justifiable at present to include the material in estimates of national reserves of manganiferous ores. Viewed as a national asset under a great emergency, however, when cost of treatment is a secondary element, it deserves consideration.

If business conditions should warrant placing this material on the market a navigable Missouri river would offer an excellent outlet by which the ore could be sent closer to the coal fields for smelting or an inlet for the importation of cheap coal into South Dakota where smelting plants could be erected to advantage near the deposits.

STRUCTURAL MATERIALS

A number of materials for structural purposes lie within reach of the Missouri River and offer potential freight should the river be open for navigation. These include several varieties of stone, sand, and gravel, all of which are at a premium either up or down the river and clays. Of the stones, chalk and quartzite lie within easy hauling distance of the river while granite, limestone, and sandstone are available with a longer overland haul. Large deposits of sand and gravel lie within easy reach of the River and clays and shales make most of its bluffs.

Chalk

Although chalk rock occurs in at least three different formations in South Dakota, only that of the Niobrara formation is worth considering for commercial purposes. The other chalks are either too thin or contain too much clay to be useable. The amount of chalk in the Niobrara formation however, is practically unlimited since it can be followed in the bluffs of the Missouri from Fort Thompson to Yankton a distance of nearly 150 miles. Over much of this distance the chalk cliffs are exposed directly above the water where the river impinges on the bank and at no place would there be more than a short wagon or truck haul from the quarry to the loading dock.

This rock makes a good building material, houses and business blocks built of it have withstood the climate of South Dakota for more than 50 years. It is also the basis of whiting which is used so extensively in the manufacturing of automobile tires and other rubber goods, paints, calcomines, and putty. It is also an excellent source of lime for plasters, concrete and similar uses.

The total thickness of the Niobrara formation is about 200 feet. In the canyon of Turkey Creek near Volin 150 feet is exposed, 9 miles west of Yankton 145 feet, and not far from Springfield 170 feet. Its top reaches the water level at Wheeler bridge and then rises in bluffs 80 feet high at Chamberlain. From this point they become gradually lower until the formation disappears beneath the river bed at Fort Thompson. When it is considered that nearly the entire southern half of the state is underlain by this formation and that it comes close enough to the surface to be quarried over large areas in the Missouri and James valleys, it can readily be appreciated that there is an unlimited volume of this material awaiting shipment.

Two samples of chalk taken from Yankton will serve to illustrate the general chemical composition of the rock.

Sample 1. White chalk taken at top of formation near old Cement Plant.

Calcium Carbonate, $CaCO_3$	92.72%
Aluminum, Al_2O_3	.28
Iron, FeO	1.16
Volatile Matter	1.57
Insoluble Matter	4.12

Sample 2. Dark grey chalk taken from quarry at old Cement Plant near Yankton.

Calcium Carbonate, $CaCO_3$	75.66%
Aluminum, Al_2O_3	1.16
Iron, FeO	2.17
Volatile Matter	11.68
Insoluble Matter	5.12 [1]

The chalk which is now used in whiting is imported almost entirely from Europe much of it coming as ballast. Under present conditions it does not seem possible to compete with this chalk in supplying whiting plants near the sea coast. Plants in such cities as Saint Louis and Chicago, however, could be supplied easily and cheaply with large quantities of this material if it could be shipped by boat. It would have no competition since similar chalks are not found on our continent easily accessible to water transportation. As a source of lime or cement it might serve a large area up the river including northern South Dakota, North Dakota, and eastern part of Montana and might even compete in this respect with limestones in the lower river as far south as Omaha. Return loads of coal from either North Dakota or St. Louis would make an attractive commerce for large operators.

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1. Analyses by State Chemical Laboratory, Guy G. Frary, Chemist.

Quartzite

Hard rocks are difficult to obtain in the Missouri basin above southern Nebraska. For this reason it is possible that an appreciable traffic might be developed from the quartzite that lies between Sioux Falls and Mitchell. This rock could be delivered to river boats from the quarries with a 60 mile haul and would then be available to the country along about a thousand miles of the river where such rock is not to be had. It occurs in unlimited quantities as it underlays the soil mantle over 1800 square miles of eastern South Dakota and is at least 1500 feet thick. It is easily accessible at East Sioux Falls, Sioux Falls, Parker, Spencer, Alexandria, Mitchell, and other places.

The stone is a pink quartzite sometimes known to the trade as pink granite. It is dense and hard and will withstand both the wear of traffic and the ravages of weather. Its crushing strength is nearly that of granite, 12,000 pounds to the square inch being about the average. For these reasons it has been used for paving material, polished for ornamental stones, crushed for concrete aggregate, hewn into blocks for building purposes, and into slabs for rip rap.

This stone is now (1939) being used for rip rapping the river south of Sioux City. Rock from the quarries located near Garretson is delivered to boats at Sioux City, the rest of the haul being made by river. With similar delivery from any of the points mentioned above to Elk Point, Sioux City, or Yankton this rock could be sent to large districts up the river in South and North Dakota and Montana.

Granite

Ornamental granites occur in South Dakota in the vicinity of Milbank and also in the core of the Black Hills, most of that which is now going to market being shipped east of the Mississippi river. Though there is a 200 mile haul to the river from quarries in either of these places, it is conceivable that these granites might be added as ornamental stone to the traffic which the river might carry southward and eastward.

For use as concrete aggregate, building stone, rip rap etc. other granite closer to the river might give competition impossible to meet. The market of ornamental stone, however, depends so largely on characters such as color which cannot be duplicated in other places that South Dakota granite could have a place in commerce if it could be cheaply transported to the far away markets.

Limestone and Sandstone

Hard limestones and sandstones occur in the Black Hills which are suitable for lime or converting into building stone. It is doubtful whether such stone would add much to river traffic, however, because of its location. Similar stones are to be found along the Missouri river in states farther south and it is doubtful whether the South Dakota rocks could compete with them due to the long overland haul necessary to place them on the river boats.

Sand and Gravel

Sand and gravel, especially the latter, are not easily obtained in a large area bordering the lower Missouri river south of Omaha. For this reason, it would seem that the great deposits which occur in and near the Missouri valley in our state could form an important material for river freight. Unfortunately, there never has been an opportunity to make a systematic inventory of the gravels along the Missouri. But sufficient information has been gleaned in several surveys which crossed the valley and from general observation to assure a large volume available for such commerce.

At three places along the river, gravel deposits whose volume can be measured in millions of cubic yards are known. These deposits offer the cheapest kind of transportation since gravel can be loaded directly onto boats from the pit. At least two great outwashes are known to lie within a 15 mile haul of the river. The area of some of these outwashes includes an entire township. These deposits could furnish enormous quantities of gravel for river freight. Similar outwashes are distributed from Campbell to Sully county. Large gravel deposits along the Big Sioux Valley are accessible to the river with a short haul.

An appraisal of the gravel in Yankton county was made some years ago and it is, by the way, the only county bordering the river in which an appraisal has been made. This county is not well supplied with gravel but the survey showed some 8 million cubic yards in the James valley, more than 2 million in the lower Beaver valley and 1½ million yards in the valley of Turkey creek. Another area in which careful estimates have been made lay in Edmunds county where a narrow strip (6 miles) along the State highway gave a total of more than 11 million cubic yards. These are but samples which indicate that if gravel business should be developed as a result of river navigation there is enough material to keep this industry thriving for a great many years.

Clay

The glacial clays and marine shales which make so large a part of the bluffs of the Missouri once offered the materials for brick and tile plants that flourished in all the larger towns along the Missouri. So far as raw materials go there is no reason why similar plants should not again produce these commodities which should be extremely important to the Missouri river country in view of the rising price of lumber. The present drawback is the cost of fuel, but fuel brought in on river boats would do a great deal to solve this difficulty.

So far as is now known brick and tile clays are the only ones available in large quantities near the river. Fire clays have been found in the outcrops in the Black Hills and are known to underlie coal beds in northwestern South Dakota. Some of these may be turned to account later but it is doubtful if they could add a large volume to river traffic. Pottery clays such as those which have been used in North Dakota also occur in northwestern South Dakota.

Bentonite which is now coming to the foreground industrially can be supplied from our state. The thickest seams are found in the vicinity of the Black Hills and therefore would need a long rail haul to water. For transportation to the eastern part of the United States it is possible that this material might be added to the river traffic. From the information at hand, it is certain that enough bentonite occurs in this vicinity to supply the demand now in existence for a great many years. Bentonite also occurs in the bluffs of the Missouri valley, but it is doubtful whether any of it occurs in seams sufficiently thick or sufficiently close together to pay for commercial exploitation. In 115 feet of Agency shale which outcrops opposite Whitlocks Crossing in Potter County, there is a total of four inches of bentonite. This occurs in five different beds. The other outcrops in which the bentonite has been measured show total thicknesses of 5 to 10 inches disseminated in 10 beds through 18 feet of shale. A 3½ feet shale zone included 5 bentonite streaks 2 inches or less in thickness near Steamboat Creek. Another member of the Pierre formation, the lower Virgin creek, contains about 18 beds in a total thickness of 80 feet. These beds are all thin, however, 1 and 2 inches being a maximum. In a study of Virgin Creek bentonites it has been estimated that there are only 58.5 cubic feet of bentonite in 68,064 cubic feet of shale. This is hardly a large enough volume to interest commercial exploitation.

FUELS

Coal

Though an old estimate by the Federal Geological Survey gives a total of two billion tons of lignite coal in northwestern South Dakota, none of it lies close to the Missouri. The nearest is mined at Firesteel nearly 50 miles west of the river. A second difficulty in the water export of this coal is the fact that railroads do not serve this coal field and a long truck haul is necessary from most of the mines.

The coal is a good grade of lignite much of it bordering on the rank of sub-bituminous, having a heat value ranging from 7,000 to 12,000 B.t.U.

Coal beds of the South Dakota field, as in other fields, are lenticular. The thickest portions of the beds are near the center and they pinch out at the borders. The coal beds of the Hell Creek member of the Lance and some beds of the Ludlow member of the Lance are of lenticular character since they cannot be traced over large areas. Most of the Ludlow and the Fort Union coal beds are of considerably wider extent but these, the latter in particular, have been dissected by stream erosion so that lenses originally covering many square miles have been cut into smaller patches.

South Dakota coals have most of their physical characters in common, although important differences occur. They range in color from dark brown to black. The streak (color of the powdered coal) of all, however, is brown. The coal of most, if not all of the beds is made up of three kinds, dull, coal, glance coal, and fusain or mineral charcoal. The dull coal is commonly dark brown, although in many places it is black. Furthermore, dull coal has but little gloss or luster. In some beds the dull coal is tough and fibrous. Glance coal is black, has a high luster and is commonly more or less brittle. In most cases glance coal appears, in cross or vertical section of the coal beds, as small lenses of bright coal between laminations composed of dull coal. In sections parallel with the bedding it appears in elongate masses, which, in favorable situations, assume the outline of much compressed branches and trunks of trees. Indeed, in many cases the grain of the wood is sufficiently well preserved in glance coal of South Dakota beds to be evident to the naked eye. Fusain, or mineral charcoal, has the appearance of

fragments of charcoal, distributed irregularly on the bedding planes. This variety has not been a common constituent of coal in this field, although it is abundant in some beds.

Some coal beds also contain thin beds of black, more or less highly carbonaceous clay or shale which is very similar to coal. This material is locally known as "black jack" and corresponds to "bone" or "bony coal" of eastern coal fields.

When fresh the coal contains from 29.8 to more than 46.5 percent of moisture, and averages about 37.56 per cent. Drying in air reduced the moisture content from these percentages to a minimum of 2.3, a maximum of 18.8, or an average of 9.5 per cent.

Moisture content of South Dakota coal is most important since coal shipped or hauled as mined contains more than one third water, which is valueless as fuel. Drying before transportation as shown by the above figures, greatly reduces this excess water content. Loss of water in drying, however, causes the coal to shrink very considerably with the result that it checks and breaks into small pieces, in some cases to fine material incorrectly called "slack coal". Moisture content of the South Dakota coal and the behavior of the coal due to loss of water on drying are among the most important problems in the utilization of this fuel.[1]

It is the same quality of coal as that mined in North Dakota and would have to compete as river traffic not only with the North Dakota coal but with higher rank coals from Iowa and the Appalachian fields. It is, therefore, somewhat of a question as to whether this coal could be a factor in river traffic in the state. There is no question, however, but that it could be distributed farther and much more cheaply than it is at present if river navigation were available.

Oil Shale

Looking far into the future, oil shale could be a very important factor in river transportation. A thick zone of oil shale lines the Missouri bluffs at least as far north as the Big Bend and oil has been extracted from other shales in the

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1. Walter V. Searight, A Preliminary Report of the Coal Resources of South Dakota, Report of Investigations No. 3. S. Dak. State Geological Survey, 1930, p. 23.

Big Sioux valley and the bluffs opposite Vermillion. Pool oil is now supplying the market but as time goes on and the price of oil advances, oil shales will have to be used as a source of petroleum. This industry is already in operation in Europe and it is probably but a matter of time until this will be a thriving industry in our own country.

Unfortunately, there has been no opportunity to appraise the potentialities of this shale but if the qualitative tests which have been possible are any indication there is no doubt but that the shale should furnish large quantities of oil.

Whether river transportation would move the shale to refineries or whether they would refine the products in South Dakota it could be an important item in river commerce.

Gas

Small quantities of gas have been produced steadily from artesian wells in the vicinity of the Missouri for more than 30 years. This gas belt reaches from the vicinity of Pierre northward and slightly eastward nearly to the state line. While gas will never travel as river freight it is included here as one of the possible resources of the upper Missouri, its main interest being in the possibilities it holds as furnishing a fuel which could supply power for other industries along this part of the river. Systematic tests for larger supplies of gas have never been made and a thick section of possible gas bearing rocks underlying the artesian water horizon in this region offer excellent prospecting. Until further drilling discloses larger amounts of gas it cannot be considered as an important resource of the Missouri valley but in its present condition it offers an interesting suggestion of what might be possible in the future development of river traffic.

CONCLUSION

From a survey of the foregoing it would appear that the chief benefits of river traffic would be the possibility of introducing cheap fuel into South Dakota in the form of coal from the eastern and Rocky mountain coal fields, and the exporting of such products as sand and gravel, chalk rock or whiting and possibly clay products like brick and tile. With these as the chief mineral products, minor ones would undoubtedly follow. Bentonite, volcanic ash, possibly feldspars from the Black Hills and perhaps even lignite from our own coal fields could offer additional freight. Whether these will develop or not will depend largely on the demand for such products outside the state and the initiative of South Dakotans in developing and marketing these resources.