

ASPHALT.

OSOKERITE DEPOSITS IN UTAH.

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LOCATION.

The only known deposits of ozokerite in Utah are located in the north end of the Wasatch Plateau, near the Denver and Rio Grande Railroad. This mineral wax occurs here in three groups of localities—(1) in the vicinity of Colton, on the north side of Price River Valley; (2) near and to the east of Soldier Summit, where the railroad crosses the crest of the plateau; (3) near Midway station, on the north side of the canyon, near the source of Soldier Creek and west of Soldier Summit. Colton is 7 miles southeast and Midway 3 miles west of Soldier Summit.

FEATURES OF THE COUNTRY.

The Colton and Soldier Summit localities are in Price River Valley, which trends toward the southeast, and has here a rather broad, flat channel. On the southwest the slopes rise gradually with the inclination of the strata. On the opposite side, toward the northeast, beginning half to three-fourths of a mile from the river, the ascent is more abrupt and is made in a succession of high benches and knobby spurs to the crest of the Roan Cliffs. Midway station is in a gorge that trends westward near the source of Soldier Creek. Ozokerite deposits occur in the gulches making into the valley from the north side. The surface of the country is clothed with sagebrush except in the upper stretches of the gulches and valleys facing toward the north and west, where groves of aspen, chokecherry, service, and scattering pines grow.

GEOLOGIC RELATIONS.

The ozokerite deposits occur in shales, shaly sandstones, and limestone strata in the lower part of the Tertiary deposits of the "Wasatch" group. The mineral has been found at various positions through a section of about 500 feet of strata. The shales are friable, variously tinted purple, green, blue, and white. The sandstones are moderately soft, and light drab and brown in color. The limestone beds are thin and brittle, and vary from white to shades of yellow and blue. The limestone deposits occur both below and above the section containing ozokerite.

The rocks are uniformly tilted toward the northeast about 5°. At the localities inspected near Colton, Soldier Summit, and Midway the strata are intersected by fissures and zones of brecciation and parallel jointing. These fissures and spaces between brecciated rock contain the ozokerite, usually as thin films and sheets but locally as dike-like bodies several inches thick, and it is reported several feet thick in places. The faces of the fissures and also the brecciated portion of the rock show the effects of movement in slickensided surfaces. In many instances also the surfaces of the ozokerite deposits exhibit the same phenomena. The vertical displacements along these fissure veins, so far as could be determined, have been slight where the inspection was made in the mines and prospects. The

study of the surface conditions did not reveal appreciable faulting. The fissures and joint planes are almost vertical, and near Colton and Soldier Summit they bear approximately N. 10° W. One-half mile west of Midway station a fracture zone containing ozokerite bears N. 30° W. Another half a mile northeast of the same station has a trend N. 60° W. In both instances the fractures were almost vertical.

Though the ozokerite has been mined or prospected at several points through a stratigraphic range of nearly 500 feet, it has not been shown that there is any systematic variation in the thickness of the deposits. It has been found to be locally variable both laterally and vertically.

NATURE OF THE MINERAL.

Three samples were selected for laboratory tests, one from the mine half a mile northeast of Midway station, a second from the mine at Colton, and a third from the mine 1½ miles north of Colton. These samples were subjected to fusion and solution tests made in the Geological Survey laboratory by Eugene C. Sullivan.

The mineral occurring near Midway and Soldier Summit and at the mine in the town of Colton has essentially the same physical appearance. The slight variations in hardness and color are not greater than are found to occur at a single locality. In places the ozokerite has been crushed and intimately slickensided, as is the case with the material collected from the Colton mine. The mineral is thereby rendered more friable than where such pressure and movement of contact strata has not occurred. Under ordinary conditions the mineral is semibrittle and slightly friable, but a mass can not be crushed or molded between the fingers. It cuts easily, somewhat like hard cheese, but does not adhere to the knife. It is for the most part black, and here and there yellowish resinous parts blend with the black. In the Midway mine certain parts were distinctly fibrous and yellow, as if a purer material had been blown into or had percolated through open spaces in the darker product.

The mineral at the Midway locality melts at 64° C., is completely soluble in boiling ether, and has a faint petroleum odor. The Colton product melts at 70° C., is incompletely soluble in boiling ether, and has no odor. The material of the third test, from the deposits 1½ miles north of Colton, is entirely black, has a pronounced petroleum odor, and can be molded in the fingers. Its melting point is 54° C., and it is completely soluble in boiling ether. The mineral from this locality, as well as from others in the vicinity north and northeast of Colton, contained more bitumen or asphalt than the Midway and Colton samples, which accounts for its lack of color, softness, and lower melting point. In concluding his report on the tests of the samples, the chemist remarks that they behave like paraffin on heating, and are ozokerite or closely related substances.

DEVELOPMENT.

The pioneer work and a large part of the development of ozokerite in this region are due to the efforts of Mr. R. J. Kroupa, who began prospecting in the vicinity of Midway in 1886. Mr. Kroupa, who now lives at Provo City, Utah, gave material aid to the writers in the investigation of the ozokerite deposits.

Ozokerite has been exploited commercially at five and probably more localities in this field. Many prospects in the neighborhood of these mines have been made, showing the presence of the mineral. From a few of these surface workings it is reported that a considerable quantity of ozokerite has been removed. Five mines have been equipped with more or less complete facilities for exploitation, and three plants have been established for separating the product from the associated rock materials.

Colton district.—One of the mines in this district is located at Colton. A shaft is sunk on a vertical shear zone 5 to 6 feet in width to a depth of 110 feet and is equipped with a 10-horsepower hoisting engine. Drifts have been run on the strike of the fractures at a depth of 45 feet and at the base. The mine is now closed, it is claimed, on account of litigation. At the time of inspection it was filled with water below the 45-foot drift. At

this level the brecciated zone consists of broken green and purple shale with sandstone fragments. Ozokerite occurs in scales or thin veins or as pockets and veins of variable extent and width not exceeding a few inches at most. Several hundred pounds of the commercial product are on hand and it is reported that the total output has been about 10 tons.

Another mine has been operated $1\frac{1}{2}$ miles northeast of Colton, very near the southwest corner of sec. 13, T. 11 S., R. 8 E. It is on a different fracture zone from that of the Colton mine and nearly 500 feet higher in the strata. At this place a tunnel has been driven 225 feet N. 10° W., on a shear zone of brecciated sandy shale 4 to 6 feet wide. At the end of the tunnel a drift is driven 125 feet toward the east. A space of vertical fractures is crossed in this drift 65 feet east of the tunnel. A shaft said to be 100 feet in depth has been sunk at the mouth of the tunnel and drifts run north and south at a depth of 60 feet. The faces of the fractured shale showed much slickensiding. Small quantities of ozokerite occur here and there as thin films in the joints both in the tunnel and in the drift. The developments here are recent, but the plant was not in operation when visited.

A third mine in the Colton district is $1\frac{1}{2}$ miles north of Colton and very near the north side of the SW. $\frac{1}{4}$ sec. 14, T. 11 S., R. 8 E. At this point a tunnel was driven N. 10° W., following a line of vertical fractures. Ozokerite occurs here in thin sheets following joints and surrounding fragments of brecciated shale. Several prospects have been made on the same line of fissures in the vicinity, exhibiting similar conditions in the occurrence of the mineral. Prospects showing the presence of ozokerite have been made in the SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 14 and the NW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 15, and mining to a limited extent has been carried on in the SW. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 24, T. 11 S., R. 8 E., on similar north-south lines of jointed and fissured strata. Nowhere in the Colton district has ozokerite been seen by the writer in bodies more than a few inches in thickness.

Soldier Summit locality.—The development of ozokerite in this locality is limited to the NW. $\frac{1}{4}$ sec. 30, T. 10 S., R. 8 E., within half a mile east and northeast of Soldier Summit. A mine has been equipped with hoisting power and in connection with it a concentration plant erected nearly one-third of a mile east of Soldier Summit. The mine was closed at the time visited, on account of reported litigation. Mr. Kroupa, who directed the development here, reports that the shaft is 225 feet in depth and was driven on a band of vertical fissures that contained the mineral wax, and that drifts had been opened 50 feet to the north and south on the strike of the fractures. A north-south shear zone has been prospected one-fourth mile south of the mine. In all cases here the ozokerite is reported to occur in veinlets filling narrow fissures in the strike of the crushed strata and surrounding the brecciated shale and shaly sandstone. Locally the veins swell to a thickness of nearly 3 feet, according to Mr. Kroupa's verbal report.

Midway locality.—Two small mines have been driven on vertical fractures on shale, one situated half a mile west and another half a mile northeast of Midway station. The fracture zone in the first instance is $2\frac{1}{2}$ feet wide and bears N. 30° W. In the other the fractured strata are 4 to 5 feet wide and bear N. 60° W. The ozokerite occurs at three places as variably thin sheets in vertical fissures and surrounding fragments of brecciated rock, in a similar manner to that at Colton and Soldier Summit.

METHODS OF CONCENTRATION.

The manner of separating ozokerite from the associated rocks is a simple process. The plant as described by Mr. Kroupa consists of a steam boiler and engine, a crusher, and steam-heated vats. The soft rock and ozokerite mixture is crushed and run into long vats with narrow bottoms containing water kept at a boiling temperature. The ozokerite melts at a temperature of 54° to 70° C., and floats off as a liquid into cooling vats, while the rock is driven out along the narrow bottom of the vat by revolving screws. On cooling the ozokerite is remelted in dry pans to remove the content of moisture.

CONCLUSION.

In conclusion it is well to remark that the extent, either in thickness or length, of the occurrence of ozokerite, as of any other species of the hydrocarbon series found filling fissures or spaces between broken rock, can not be relied on far beyond the limit of prospected ground. Both the width of the fissured or fractured zone and the occurrence of ozokerite are found to be variable. In no instance in this field have ozokerite veins been reported to exceed 3 feet in width. Usually, as has been stated, the mineral is in the form of thin sheets or veinlets in fissures or spaces surrounding brecciated rock. It is evident that for profitable exploitation such ozokerite-bearing ground should contain sufficient mineral wax to form approximately 10 per cent of the rock removed for treatment.

SURVEY PUBLICATIONS ON ASPHALT.

The following list contains the more important papers relative to asphalt, published by the United States Geological Survey or by members of its staff:

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