Oil shale is a dense, fine-grained sedimentary rock that is rich in organic matter which can be converted to oil by applying heat. The organic material is composed chiefly of minute particles which are the remains of plants and animals. Oil shale contains little or no free oil that can be extracted by solvents or mechanical methods, but appreciable amounts of oil can be formed by thermal decomposition of the organic matter. The method of converting the organic material to shale oil is called retorting.

Oil shale is considered to be the Nation’s prime supplementary source of liquid hydrocarbon fuels. Utah contains extensive deposits of oil shale that are a potential source of a large amount of oil. The estimated potential oil-shale resources of Utah are second only to those of Colorado. Relatively efficient methods of mining and retorting oil shale have been experimentally devised and an oil-shale industry in Utah will develop as economic conditions change.

Shale oil has not yet been produced in the United States except experimentally, although elsewhere, as in Sweden and South Africa, it has been produced for more than 30 years. Interest in oil shale as a possible source of liquid fuel has prompted considerable laboratory experimentation and, also, the construction of some small-scale plants. Shortly after World War I several retorts were constructed near Watson with the hope that a new industry could begin in the Rocky Mountains. This industry did not materialize and the retorts were dismantled. Recently there has been increased activity in core drilling and leasing of available oil-shale lands in Utah, as well as experimentation in mining and retorting of oil shale in Colorado. Any methods developed by these retorting experiments will be applicable in the recovery of oil from Utah’s shales.

The richest and most extensive oil-shale beds in Utah are found in the Uinta Basin, in the northeastern part of the State. (See fig. 15.) These shales occur as Tertiary lakebeds of the Green River formation. In addition to the Uinta Basin deposits, thin beds of oil shale in the Green River formation have been examined at one locality on the Wasatch Plateau and at one locality in the San Pitch Mountains (Winchester, 1923, p. 114), but the extent of these beds is not known.

In the Uinta Basin a sequence of oil-shale beds of the Green River formation is exposed around the margins of the basin, except on the north side, where it is truncated and is concealed by younger strata. These beds dip toward the central part of the basin, where they are thickly covered. Within the oil-shale sequence, the highest potential oil yield is in the Mahogany ledge, a series of resistant, blue-gray-weathering oil shales, the richest of which is called the Mahogany bed. Shales of the ledge crop out in many canyons in the southern and eastern parts of the basin. The Mahogany ledge is thickest in the east-central part of the basin, along an east-west-trending strip near the 40th parallel, where it may lie as much as 2,500 feet below the surface. In the central part of the basin other oil shales, of lower potential yields, extend hundreds of feet above and below the Mahogany ledge, but the sequence of beds thins near the margin of the basin.

Samples of the Green River formation taken from many core holes
Area underlain by oil shales 15 feet or more thick yielding an average of 15 gallons of oil per ton.

Area underlain by oil shales which are low grade or unappraised.

FIGURE 15.—Oil shale in Utah.
and exploratory wells in the Uinta Basin have been assayed for oil yield by the U.S. Bureau of Mines. The results of these assays are used here to estimate the amount of shale oil resources in the Uinta Basin. Oil yields of samples from the Green River formation, representing units at least 1 foot thick, range from a fraction of a gallon per ton to 95 gallons per ton of shale.

An oil-shale sequence 15 feet or more thick that will yield an average of 15 gallons of shale oil per ton underlies an area of about 3,000 square miles in the Uinta Basin. (See fig. 15.) It is estimated that this sequence has a potential oil yield of 320 billion barrels. That part of the sequence described above, which is 15 feet or more thick and will yield 25 gallons of oil per ton, contains 120 billion barrels of oil (Duncan, 1958, p. 50). This part of the sequence underlies an area of 1,200 square miles in the east-central part of the basin.

The estimates of shale oil resources given in this report are for total potential yield and do not indicate the amount of oil recoverable. Because of a scarcity of exploratory wells in some parts of the Uinta Basin the data for these resource estimates are not complete. The estimates, however, are conservative and data from future drilling will probably indicate larger resource figures.

OTHER BITUMINOUS SUBSTANCES

(By W. B. Cashion, Denver, Colo.)

Bituminous substances other than the hydrocarbon fuels already discussed (coal, oil shale, and petroleum and natural gas), include two groups of materials, the solid hydrocarbons and rock asphalts (Abraham, 1945, pp. 66-67). In both groups, the organic material appears to have changed from an earlier form, and to have migrated from the original site of accumulation. The many varieties of these bituminous substances reflect differences in source materials and subsequent history. A number of the varieties appear to represent residues left after partial volatilization of hydrocarbons.

SOLID HYDROCARBONS

Utah contains numerous unusual deposits of solid hydrocarbons which are the result of the metamorphosis of petroleum. These comparatively hard substances are brown to black in color and have a tarry or waxy appearance. They are used in a great variety of products ranging from high-quality varnishes to insulation. Gilsonite, wurtzilite, and ozokerite are the most important solid hydrocarbons found in Utah and each of these mineraloids will be discussed separately below. Glance pitch, tabbyite, and albertite are found in minor amounts and are of little economic significance. Gilsonite, wurtzilite, and ozokerite occur in the Uinta Basin in the northeastern part of the State. (See fig. 16.) Only gilsonite is being produced commercially at the present time, but significant amounts of wurtzilite and ozokerite also have been produced. The amount of solid hydrocarbons produced in Utah from 1888 through 1961 is estimated to be about 3,880,000 short tons valued at about $90,300,000.
Gilsonite vein
Area containing bituminous sandstone deposits
X
Area containing solid hydrocarbon deposits
Bituminous sandstone or limestone locality
(OTHER THAN GILSONITE)

Letters refer to areas described in text

FIGURE 16.—Solid hydrocarbons and rock asphalts in Utah.
Gilsonite.—Gilsonite is a black, lustrous substance having the appearance of solidified tar. It is characterized by a high fusing point (over 230° F.) and is almost completely soluble in carbon disulfide (Abraham, 1945, p. 250). A major part of the gilsonite produced is converted to metallurgical-grade coke and gasoline. Gilsonite also is used in ink, floor tile, brake linings, paint, electrical insulation, battery boxes, fiberboard, and numerous other products. Gilsonite is also sent to foreign markets.

Utah is the only State that produces gilsonite, and is the only State that contains major deposits of this solid hydrocarbon. Gilsonite is important to the economy of northeastern Utah, as evidenced by the 1961 output which totaled 422,294 short tons valued at $9,916,000.

Gilsonite production began about 1888 and has increased through the years in response to growing markets, creation of new products, and improvements in mining and transportation techniques. An industry which began with pick-and-shovel mining and wagon train transportation has evolved into one which is highly mechanized. Specialized designed equipment allows the mining of large tonnages of material, and watersprays settle the highly explosive gilsonite dust which otherwise creates hazardous mining conditions. Gilsonite is mined by American Gilsonite Co., G. S. Ziegler & Co., and Standard Gilsonite Co. in the area near Bonanza, in eastern Uintah County, and the latter two companies also have mining operations in western Uintah County and eastern Duchesne County. A large percentage of the gilsonite mined by American Gilsonite Co. is transported by slurry pipeline to their refinery near Grand Junction, Colo., where it is converted to metallurgical-grade coke, gasoline, and other products. All other gilsonite is transported by trucks to railheads in Utah and western Colorado.

Gilsonite occurs in northeastern Utah in Uintah and Duchesne Counties (see fig. 16) as veins in northwest-trending vertical fractures that cut gently dipping beds of the Tertiary Duchesne River, Uinta, Green River, and Wasatch formations. These smooth-walled, linear veins range in width from a fraction of an inch to about 18 feet and the maximum length is about 14 miles. The widest veins, which occur in eastern Uintah County, have their maximum width in massive sandstones in the Uinta and the Green River Formations. The veins thin, however, when they pass from sandstone into shale. Information on the veins at depth is limited, but mining in eastern Duchesne County has reached a depth of about 1,500 feet.

It is estimated that the original gilsonite reserves of Utah amounted to about 45 million tons. This estimate is for total original reserves in place; no allowance is made for gilsonite that may not be minable because of limitations of vein width or other factors. Gilsonite produced to date amounts to about one-tenth of the estimated original reserves.

Ozokerite.—Ozokerite is a native mineral wax that occurs in deposits usually associated with paraffinaceous petroleum (Abraham, 1945, p. 140). It may be as soft as tallow or as hard as gypsum; it melts easily between about 58° and about 80° C.; and is soluble in carbon disulfide. Ozokerite is a nonconductor of electricity and is used in insulation. It is also used in high-quality candles, polishes, rubber additives, and wax figures. Much ozokerite is converted to ceresin, a
highly purified product, which is used to replace or adulterate beeswax, and has a variety of other uses (Robinson, 1916, p. 11).

Development of ozokerite deposits began in 1886, and by 1914 there were 17 small mines and prospects. Utah's ozokerite production has been sporadic and there has not been any mined in several years, although there is a continuing demand for the substance and the deposits are near transportation and other facilities. The small size of the veins and the irregular, unpredictable shape of the bodies discourage their exploitation.

Ozokerite occurs in an area of about 25 square miles in Wasatch and Utah Counties in central Utah. (See area A, fig. 16.) As described by Robinson (1916, pp. 3-16), the deposits are in the Wasatch formation in a stratigraphic sequence of shale, sandstone, and limestone, about 600-700 feet thick. The beds dip 1° to 25° northward toward the axis of the Uinta Basin. The ozokerite occurs as veins and as fillings in brecciated zones; the wall rock is not impregnated. The principal fissures trend about N. 10° W. and contain the largest deposits of ozokerite. Thicknesses of the veins range from a fraction of an inch to 3 feet. The deposits are irregular in size, and thicknesses and lengths of veins cannot be predicted far from exposures. For this reason no estimate of ozokerite reserves has been made.

Wurtzilite.—Wurtzilite is a black, lustrous, sectile substance which has an elasticity similar to mica and is only slightly soluble in carbon disulfide (Abraham, 1945, p. 291). Wurtzilite is used in calking and waterproofing compounds and preservative paints.

Information concerning the mining of wurtzilite is scarce. Production figures indicate that wurtzilite mining began about 1900 and was carried on, discontinuously, until about 1950. Mining operations were on a relatively small scale and total production was probably less than 25,000 short tons.

Wurtzilite deposits are found in an area between Avintaguin and Antelope Canyons, in Duchesne County. (See area B, fig. 16.) The deposits occur as vertical veins in gently dipping limestone and shale beds in the Green River formation (Eldridge, 1901, pp. 358-360; Davis, 1959, pp. 55-61). The veins are generally narrow and have uneven walls; some wurtzilite also occurs in brecciated zones. The widest vein has a maximum width of 4 feet and the longest has a maximum length of about 3 miles, but most of the veins are 10 to 12 inches wide and about 1 mile long. Outcrops of the veins are mostly restricted to steep slopes and cliff faces. Total resources of wurtzilite have not been estimated.

ROCK ASPHALTS

Rock asphalts are bitumen-impregnated porous rocks, such as sandstone and limestone, containing from a few percent to as much as 13 percent bituminous substances. The rock asphalt, after crushing, is used primarily for paving, and for other purposes such as a mastic for flooring, roofing, and waterproofing. In addition, the bitumen may be extracted from the associated mineral material by solvents or by mechanical means.

The most important rock asphalt deposits are in the northeastern part of Utah (fig. 16). Data on production are incomplete, but total output is estimated at about 400,000 tons. Nearly all the production has been bituminous sandstone from deposits near Sunnyside and at
Asphalt Ridge, and has been used for paving. A small production of bituminous limestone is reported, but the deposits have not been studied in detail. Some beds described as bituminous limestones, for example, may be oil shales. Many localities containing small deposits of bituminous sandstones and limestones are known, and a number of these are shown on figure 16.

**Sunny side deposits.**—The Sunnyside bituminous sandstone deposits are about 5 miles north of the town of Sunnyside, Carbon County. (See area C, fig. 16.) The bituminous sandstone beds crop out in cliffs and steep slopes in the upper part of the Wasatch formation and the lower part of the Green River formation, with the bulk of them being in the Wasatch formation (Holmes and others, 1948). The strata dip gently northeastward toward the axis of the Uinta Basin. Individual beds range in thickness from a few inches to 350 feet and extend as much as several thousand feet along the strike. These beds are numerous in a stratigraphic sequence 1,000 feet thick and occur along the outcrop for a distance of about 9 miles.

Bitumen content of beds in the Sunnyside area ranges from a few percent to a little over 13 percent by weight. Holmes (1948) estimated that the area includes about 1,600 million cubic yards of bituminous rocks in which beds with 9 percent or more bitumen by weight contain 728 million barrels of bitumen. From 1892 through 1945 intermittent quarrying operations removed about 335,000 tons of rock from the Sunnyside deposits. Shortly after 1945 mining ceased and has not resumed.

**Asphalt Ridge deposits.**—The Asphalt Ridge bituminous sandstone deposits lie a few miles southwest of Vernal, Uintah County. (See area D, fig. 16.) Impregnated beds of sandstone crop out along a northwest-trending strip about 14 miles long and less than a mile wide (Spieker, 1930). The bitumen occurs in beds of the Cretaceous Mesa-Verde and Tertiary Duchesne River formations (Covington, 1963, p. 229). Dip of the beds is southward and south westward and exploratory drilling has encountered bitumen-impregnated beds in the subsurface about 2 miles downdip from the outcrop. Thicknesses of impregnated sandstone sequences at the outcrop range from a few feet to about 200 feet.

Samples analyzed from various sandstone beds show that the bitumen content ranges from about 8 percent to a little more than 15 percent by weight. The area within 1% miles of the outcrop is estimated to include about 1,970 million tons of bituminous rock containing 1,150 million barrels of bitumen (Spieker, 1930, pp. 96-97). The Asphalt Ridge deposits have been quarried for many years to obtain paving material for streets and roads in and near Vernal; however, the amount of material quarried is not known.

**PR Springs-Evacuation Creek deposits.**—The PR Springs bituminous sandstone deposits (see area E, fig. 16) and the Evacuation Creek bituminous sandstone deposits (see area F, fig. 16) occur on the southeast flank of the Uinta Basin, Uintah and Grand Counties. The main portions of these similar deposits lie along minor northwest-trending anticlinal noses that plunge toward the structurally low part of the basin.

The impregnated beds occur in the Green River formation and crop out as cliffs or steep slopes in a well-dissected region. Maximum
thicknesses of individual beds is about 40 feet in the Evacuation Creek area and about 120 feet in the PK Springs area.

In the Evacuation Creek area there is usually only one impregnated sandstone bed, but in the PK Springs area there may be as many as four within a stratigraphic sequence 200 feet thick. Much of the area between the two deposits contains sandstone beds that also are impregnated, although to a much lesser degree than the two main deposits. Impregnation of individual beds within the main deposits is quite irregular.

Bitumen content of analyzed samples from the sandstone beds range from about 6 to about 23 gallons per ton. Impregnated sandstone beds underlie an area of at least 100 square miles, but because of the irregular nature of the impregnation no attempt was made to estimate the bitumen reserves. The deposits have not been mined, probably because of their remoteness.

Miscellaneous deposits.—Numerous small deposits of bituminous sandstone and limestone in Utah have been reported by various authors (Abraham, 1945; Barb and Ball, 1944; Boutwell, 1904; Covington, 1963; Eldridge, 1901), but few of these have been described in detail. From the available information, they are apparently of minor significance.

Most of the deposits are in beds of Tertiary age and lie within the Uinta Basin. The only exceptions are a deposit in sandstone of Jurassic age about 22 miles northwest of Vernal, and a deposit in limestone of Quaternary age on the shore of Great Salt Lake. Some of the deposits are associated with faults or unconformities but most are in undisturbed conformable rock sequences.

The impregnated sandstone beds of Jurassic age are in steeply dipping strata near the mouth of Whiterocks Canyon, Uintah County. Covington (1963, pp. 237-238) has estimated that this deposit contains 50 million barrels of bitumen.

Boutwell (1904, pp. 473-476) described thin bituminous limestones of Quaternary age that occur near Rozel Point, Box Elder County. These limestones are in lakebeds near the shore of Great Salt Lake and are impregnated with bituminous material that seeps up through fractures in the lakebeds. Some of the bituminous material permeates porous rock and some floats to the lake surface (Eardley, 1963). The limestone beds have not been worked but a small amount of the material on the lake surface was marketed for use in paving mixture. The bituminous material is believed by Eardley to derive from oil occurring in Tertiary limestone interbedded with basalt.

A review of the literature has revealed only one report of the mining of bituminous limestone in Utah. Eldridge (1901, pp. 363-364) describes a deposit about 8 miles northwest of the Gilluly rail siding, Utah County, that was mined about 1900. The deposit is in a limestone sequence of beds in the Green River formation. The beds dip northeastward into the Uinta Basin.

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