GEOLOGICAL SURVEY OF WYOMING
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SULFUR RESOURCES OF WYOMING

by

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Illustration

Introduction

Sulfur, an often unheralded mineral commodity is currently produced in Wyoming as a by-product of sour gas-processing plants. Sulfur has also been mined in Wyoming from natural sulfur deposits in the past. Sulfur prices are currently rising in response to an increase in the national consumption rate (U.S. Bureau of Mines, 1983-1985) and the depletion of stocks of Canadian sulfur (Morse, 1986). The price of sulfur has increased from $104.68 per ton in 1985 (Morse, 1986) to $141.50 in May, 1986 (Engineering and Mining Journal, 1986). The 1987 price is expected to reach $200.00 per ton as Canadian stocks are depleted (Urquhart, 1986). The 1985 consumption of sulfur in the United States was 12,679,000 tons. Imports account for about 16 percent of consumption. Most of the imported sulfur comes from Canada (64 percent) and Mexico (36 percent) (Morse, 1986).

Elemental sulfur is generally converted to sulfuric acid before its use. Sulfur is used for fertilizer (65 percent), chemical products used by various industries (10 percent), petroleum refining (7 percent), and metal mining and milling processes (3 percent). The remaining 15 percent is used in a wide variety of industrial products, including rubber and plastic products (Morse, 1985).

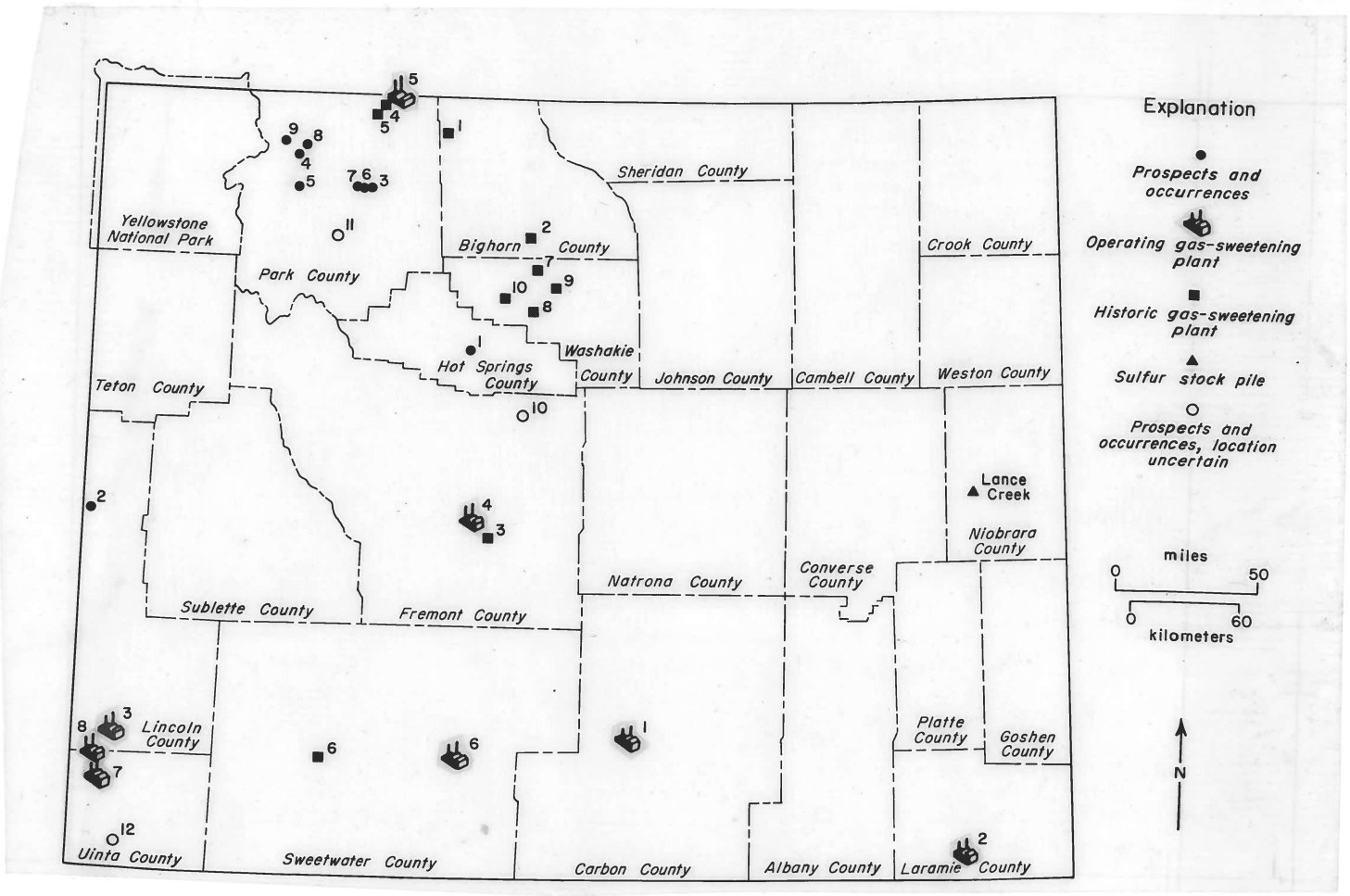
According to the U.S. Bureau of Mines (written communication 1985), Wyoming produced about 690.6 thousand short tons of sulfur in 1984 at a value of almost $50 million. By the end of 1986, Wyoming's natural gas plants will have a design capacity of about 3,400 short tons per day of elemental sulfur. All of this sulfur comes from the desulfurization of sour natural gas (gas containing

hydrogen sulfide). The operating sulfur-producing plants are shown on the accompanying map. Some Wyoming sulfur is sold to phosphate processing plants, such as Stauffer Chemical Company's plant at Leefe, Wyoming, for the production of fertilizer. The sulfur from Chevron, Inc.'s Carter Creek natural gas processing plant is to be used in Chevrons' phosphate fertilizer plant located four miles southeast of Rock Springs.

In Wyoming, all natural sulfur prospects and verified occurrences are at sites of active and fossil hot spring systems. The native sulfur is often associated with travertine, gypsum and petroliferous material and sometimes with pyrite and iron oxides. The highest sulfur contents are found in limestone host rocks. The deposition of native sulfur is a complex process. Sulfur, sulfate and(or) sulfide-bearing hot water probably deposited sulfur in open spaces and replacement bodies by a combination of cooling, reduction, oxidation and(or) acid neutralization. Oxidation and reduction can be accomplished by both chemical and biological means, and sulfur-bearing acidic water could be neutralized by limestone. The association of sulfur with hot springs and petroliferous material implies the source of the sulfur might have ultimately been hydrogen sulfide-bearing natural gas derived from Permian rocks.

The names and sites of inactive natural gas processing plants, and natural sulfur prospects and occurrences are shown on the accompanying map. The production from individual gas-processing plants has been sporadic and the amount of sulfur produced is not known. Inactive plants are still of interest because native sulfur stockpiles may be present at plant sites. Sulfur has been produced from natural sulfur deposits at Thermopolis, Cody, and Auburn Hot Springs.

Production records from these deposits are incomplete. The natural sulfur prospects and occurrences could be productive as sulfur prices rise, but potential reserves are not well defined.



Prospects and occurrences

1) Thermopolis area
2) Auburn Hot Springs
3) Cody area
4) Sunlight Basin area
5) Sweetwater Mineral Springs
6) Shoshone Canyon Conduit
7) Buffalo Bill Reservoir
8) Little Sunlight Creek
9) One Hunt Creek area
10) Bonneville "Mercury" prospect area
11) Rock Creek
12) Southeast of Evanston

Active gas processing plants and refineries

1) Sinclair
2) Cheyenne
3) Shute Creek
4) Beaver Creek
5) Elk Basin
6) Table Rock
7) Whitney Canyon
8) Carter Creek

Historic gas processing plants

1) Garland
2) Manderson
3) Big Sand Draw
4) Silver Tip
5) Ralston
6) Rock Springs
7) Worland
8) Neiber Dome
9) Cottonwood Creek
10) Fourteen-mile

Index map showing sulfur prospects and occurrences, and active and historic gas-processing plants and refineries.

Active sulfur producing gas-processing plants

The following eight Wyoming gas-processing plants and refineries produce sulfur as a by-product of the desulfurization of natural gas. At Sinclair and Cheyenne, sulfur is recovered from natural gas which is a product of the refining of crude petroleum. The number preceding each plant refers to the number on the location map, page 4 (U.S. Bureau of Mines, written communications, 1985).

Carbon County

(1) Sinclair, Wyoming refinery, Sinclair Oil Company - 27.6 short tons per day

Laramie County

(2) Cheyenne, Wyoming refinery, Frontier Oil and Refining Company - 55.2 short tons per day

Lincoln County

(3) Shute Creek site, Exxon gas-processing plant (nearing completion) - 800.0 short tons per day

Fremont County

(4) Beaver Creek oil and gas field, Amoco gas-processing plant - 67.0 short tons per day

Park County

(5) Elk Basin oil and gas field, Amoco gas-processing plant - 84.0 short tons per day

Sweetwater County

(6) Table Rock oil and gas field, Colorado Interstate Gas gas-processing plant - 97.3 short tons per day

Unita County

(7) Whitney Canyon oil and gas field, Amoco gas-processing plant - 1,309.0 short tons per day

(8) Carter Creek oil and gas field, Chevron gas-processing plant - 985.0 short tons per day

Historic gas-processing plants with sulfur production

(Biggs and Espach, 1960; Kelly, 1962)

The following list of historic sulfur producing gas-processing plants is probably incomplete because complete records were not kept by the producers.

Many more fields than those listed below produce or produced natural gas containing hydrogen sulfide. Often the disposition of this gas is not known. Sometimes it was flared, some was processed to remove hydrogen sulfide on site, with or without elemental sulfur production and(or) some was sent to another location for hydrogen sulfide removal (after Biggs and Espach, 1960). Valuable sulfur stockpiles might be present at, but are not restricted to, sites of historic gas-processing plants. A sulfur stockpile was present at the Worland plant in 1985, while U.S. Bureau of Mines information (written communication, 1983, 1985) indicates the sulfur from Husky's Ralston plant was removed soon after the plant was shut down in 1982. An example of sulfur stock-piles at sites other than historic gas-processing plants is the sulfur in tanks in the Lance Creek oil and gas field in 1985.

Production from these plants is not known, because records of production were not kept, and the period and rate of production were not reported. Wyoming did not tax sulfur production. Plant capacity per day is given where known. The number preceding each location corresponds with the numbered locality on the map, page 4.

Big Horn County

(1) Garland oil and gas field
(2) Manderson oil and gas field - 120 tons per day

Fremont County

(3) Big Sand Draw oil and gas field

Park County

(4) Silver Tip oil and gas field - 50 tons per day
(5) Ralston oil and gas field

Sweetwater County

(6) Rock Springs (city) from Baxter Basin oil and gas field

Washakie County

(7) Worland oil and gas field - 350 tons per day

(8) Neiber Dome oil and gas field - 23-50 tons per day
(9) Cottonwood Creek oil and gas field - 20 tons per day
(10) Fourteen-mile oil and gas field - 20-50 tons per day

Sulfur Prospects

The number preceding each prospect description refers to the locality on the map, page 4.

Hot Springs County

(1) Thermopolis area (Brutch Sulfur Deposits) — center and SW1/4 sec. 21 and N1/2 sec. 28, T.43N., R.95W.

These prospects are about 3.5 miles northwest of Thermopolis on the north and south sides of Cedar Ridge. The sulfur is associated with hot spring deposits, containing travertine and gypsum, in altered Dinwoody and Park City Formations (Triassic and Permian). Two varieties of sulfur are reported, a yellow crystalline or massive native sulfur, and a brown to black massive impure sulfur that might contain an oil residue. Sulfur is present in irregularly shaped bodies, ranging in size from inches to maximum dimensions of about 100 feet laterally and 40 feet thick. Sulfur has been observed to a depth of at least 100 feet. Mineralization occurs in crevices, channels and cavities, as pods, lenses and veins. Samples from these deposits contain less than one percent to 35 percent sulfur and possibly up to 80 percent sulfur. Since 1908, sulfur has been mined intermittently from open pits and underground workings. The deposits were mined in 1908, 1922-1923, and 1945-1947. Production in 1908 was 200 tons of native sulfur. Production for 1922 and 1923 is not known, but the dumps are small. During the latest operation (1945-1947) 15,000 tons of sulfur-bearing material was mined for direct use as a soil conditioner (Beeler, 1907; Woodruff, 1909: Majors, 1946; Wideman, 1957).

Lincoln County

(2) Auburn Hot Springs — NE1/4SE1/4 sec. 23, T.33N., R.119W.

Sulfur is present in travertine terraces in Quaternary alluvium and in sludge at the bottom of pools at these springs. Native sulfur is reported on the rims of pools and disseminated in travertine. The disseminated sulfur is several hundred square yards in extent. Travertine samples reportedly contain as much as 90 percent sulfur, while the sludge contains from three to 40 percent sulfur. Two unsuccessful attempts were made to process the sludge in the winter of 1948-1949 and in 1952. Production is not known (Wideman, 1957; Wilson, 1951).

Park County

(3) Cody area — secs. 3, 4, 10, 11 and 15, and lot 63, T.52N., R.102W.

This scattered group of prospects is three to five miles west and southwest of Cody around the eastern and southeastern base of Cedar Mountain. Sulfur is always associated with Quaternary travertine, and is present in the travertine, Quaternary terrace gravels and slope wash, and in the Dinwoody and Park City Formations (Triassic and Permian). Sulfur is most abundant in limestones of the two formations (which contain 30 to 50 percent sulfur), and it is associated with lesser amounts of gypsite and selenite in sections 3, 10 and 15. Small particles of asphaltum were reported in some workings. Sulfur is very irregularly distributed in terms of prospect locations, and its configuration and content within a prospect. Native sulfur is present in pockets, narrow channels, veins and as disseminated material in irregularly shaped layers from one to 63 feet thick. The lateral extent of the layers is not reported, but depicted extents range from about 200 yards across up to 400 by 800 yards. Sulfur ore

was mined from small pits in 1906-1907, 1916-1917 and 1951-1952. The only recorded production is from 1906 when 850 tons of native sulfur were produced. The sulfur might have originated as hydrogen sulfide from Permian limestones (after Trumbull, 1907; Woodruff, 1908; Hagner, 1942; Wideman 1957; Bullock and Wilson, 1969).

(4) Sunlight Basin area — unsurveyed, estimated location T.54-55N., R.106W.

Six areas form a 3.5-mile long, northwest-southeast oriented trend through Sulfur Lake on both sides of Sunlight Creek. The alignment might be along a fracture zone. These areas are three to 30 acres in size, and are devoid of vegetation. Bleached and decomposed igneous rocks are visible at the surface in these areas (Eocene Wapiti Formation of Pierce and others, 1982). Travertine or hot springs are not present, but silicification has occurred. Sulfur mineralization occurs at smaller sites within the bleached areas, and more than one sulfur site can be present in a bleached area. Gypsum, pyrite and jarosite(?) are also present in the bleached areas. Native sulfur with or without impurities occurs as cement in an angular-clast breccia and in open fractures of altered volcanic rocks. The breccia might be slope wash and weathered material because vegetation was incorporated into it. The sulfur content ranges from a trace to 60 percent sulfur. The lateral and vertical extent of sulfur mineralization is not reported. The sulfur mineralization has been explored by means of pits, bulldozer trenches, and auger and core drilling. A few carloads of ore were tested in 1952 and 1953. In 1951, sulfur was reportedly found in bedrock limestones, but sedimentary rocks are not exposed in the area (after Hewitt, 1913; Wideman, 1957; Pierce and others, 1982).

(5) Sweetwater Mineral Springs unsurveyed, estimated location T.52N., R.106W.

This locality is about 3.5 miles upstream from the North Fork of the Shoshone River on Sweetwater Creek. Siliceous sinter and travertine containing oil, asphaltum, native sulfur, iron oxides and pyrite(?) are present on both sides of the creek. The spring deposits are in bleached and decomposed colluvium, volcanic conglomerate and agglomerate (Eocene Wapiti Formation of Nelson, and others, 1980) and in 20 feet square blocks of Paleozoic carbonates. Sulfur is also present in bedrock fractures. The sulfur content ranges from a trace to 50 percent sulfur. A narrow strip of sulfur-bearing material is present for about 1,400 feet along the stream. At the springs, the sulfur-bearing material extends about 400 feet above the creek on the east side of the drainage. The thickness of the sulfur-bearing material is not known. Only the south end of this locality has been prospected. (after Hewitt, 1914; Love and Good, 1970).

Sulfur Occurrences

The number preceding each occurrence refers to the locality on the map, page 4.

Park County

(6) Shoshone Canyon Conduit T.52N., R.102W.

The Heart Mountain Irrigation District Shoshone Canyon Conduit through Cedar Mountain intersects caverns in the Madison Limestone (Mississippian). Within these caves bulbous masses of sulfur form (coat?) stalactites and stalagmites (Love and Good, 1970; J.D. Love personal communication, 1986).

(7) Buffalo Bill Reservoir secs. 11 and 12, T.52N., R.103W.

Springs covered by Buffalo Bill Reservoir were oil- and sulfur-bearing. Sulfur-bearing travertine deposits are present on both sides of the west end of

Shoshone Canyon. These deposits are in Quaternary colluvium and in the Pennsylvanian Tensleep Sandstone, Permian Park City Formation and Triassic Dinwoody Formation (Love and Good, 1970; Pierce, 1970).

(8) Little Sunlight Creek unsurveyed, estimated location T.55N., R.106W.

The exact location of this occurrence is not known. It is reportedly four miles northeast to three miles north of the Sunlight Basin prospects. Nothing more is known (Hewitt, 1913; Wideman, 1957). Nelson and others, (1980) do not mention sulfur mineralization in this area, but they depict three claims on Little Sunlight Creek.

(9) One Hunt Creek area unsurveyed, estimated location T.55N., R.107 or 108W.

This area of alteration and sulfur mineralization is in the Wapiti Formation (Eocene) on a tributary to One Hunt Creek (Nelson and others, 1980).

The following occurrences are speculative and unverified, and their locations are uncertain.

Fremont County

(10) A mile or two north of the Bonneville "Mercury" prospect (sec. 12, T.39N., R.93W.), a claim holder reported a pit containing alum and sulfur. Hagner (1942) mentions it, but he did not visit this pit.

Park County

(11) Clabaugh and others (1946) depict a sulfur occurrence near Rock Creek in the south central part of T.50N., R.104W. This occurrence has not been verified.

Uinta County

(12) U.S. Geological Survey Mineral Resources reports from the 1880's claim sulfur was present southeast of Evanston (Williams, 1887; Day, 1888). However, the locations in these reports are flawed. The sulfur occurrences might be along Sulfur Creek southeast of Evanston.

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