# Wyoming Bentonite

## Summary Report
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## Introduction

Bentonite is a fine clay material mined from the earth, formed by the decomposition of volcanic ash deposited millions of years ago in an ancient inland seaway. It is widely used as a drilling mud for oil and natural gas wells; other uses include cat litter, cosmetics, a binding agent in animal feed, and a foundry-sand bond in iron and steel foundries.

The clay's industrial use ties it directly to the Wyoming and U.S. energy industry. Bentonite has been mined in Wyoming for more than 125 years. The state leads the nation in the production of bentonite, and has 70 percent of the world's known deposits.

Wyoming's annual bentonite production has risen from 393 tons in 1921 to 4.1 million tons in 2013. Mining operations are located in four districts: Clay Spur District (Northern Black Hills), Colony District (Southern Black Hills), Kaycee District, and Eastern Bighorn Basin District.

## History

Bentonite was originally known as 'mineral soap' or 'soap clay.' Wilbur C. Knight, a pioneer geologist who came to Wyoming in 1897 and who served as state geologist, first used the name *taylorite* for this material in an article in the *Engineering and Mining Journal* (1897). The name came from William Taylor of Rock Creek, the owner of a nearby quarry in Albany County. Taylor made the first commercial shipments of the clay in 1888. After Knight learned that the name *taylorite* had been previously used in England for another mineral he decided to rename the clay bentonite.

One of the first occurrences of bentonite was found in the Cretaceous Fort Benton Group of the Mowry Formation near Rock River, where it was also first mined. The Fort Benton Group, along with others in stratigraphic succession, was named after Fort Benton, Montana in the mid-19th century by F.B. Meek and F.V. Hayden of the U.S. Geological Survey.

## Geology

Bentonite is a montmorillonite-type clay (a hydrous silicate of alumina) that was developed from the alteration of volcanic ash in seawater. The Upper Cretaceous shallow sea in which much of the ash fell covered Wyoming about 94 to 98 million years ago during the deposition of the Mowry Shale. Bentonite also had similar derivations in rock units both older and younger than the Mowry Shale.

The Fort Benton Group, or Benton Formation, included Upper and Lower Cretaceous units lying between the Niobrara and Cloverly formations and their equivalents. Currently, equivalent stratigraphic units in Wyoming include: the Frontier Formation, Carlile Shale, Greenhorn Formation, Belle Fourche Shale, Mowry Shale, Aspen Shale, Muddy Sandstone, Newcastle Sandstone, Thermopolis Shale, Skull Creek Shale, and Bear River Formation.

The highest quality Wyoming bentonite is found primarily in the Upper Cretaceous Mowry Shale.

Bentonite includes any natural material dominantly composed of clay minerals in the smectite group. Swelling bentonite contains a high concentration of sodium ions and will substantially increase in volume when it is wetted with water.

The bentonite in Wyoming likely originated from intense, explosive volcanism associated with the emplacement of the Idaho batholith in what is now Idaho. Multiple scattered sources are hypothesized with various pulses of volcanism correlating to periods of folding and mountain building in Wyoming and adjacent areas. Cyclical stratigraphic sequences relating the deposition of the bentonite layers are recognized in most bentonite-hosting rock units (Slaughter and Early, 1965).

## Mining

Bentonite is currently mined in Wyoming from numerous surface-mining pits across the state. Major producing districts include the Northern Black Hills (Colony) District, the Southern Black Hills (Clay Spur) District, the Kaycee District, west of Kaycee, and the Eastern Bighorn Basin District (see map on back page). For economic reasons, surface mining generally extends to depths no greater than 50 feet. Bentonite mined from open pits is blended, ground, dried, and processed into various products at several mills in the state.

Table 1. Wyoming Bentonite Production 1921 - 1937 (Heathman, 1939).

| *Year* | *Short tons* | *Total Produced Value* |
|---|---|---|
| 1921 | 433 | $2,155 |
| 1922 | 466 | $7,313 |
| 1923 | 614 | $10,448 |
| 1924 | 23,716 | $41,172 |
| 1925 | 2,584 | $63,657 |
| 1926 | 4,409 | $96,853 |
| 1927 | 7,498 | $121,146 |
| 1928 | 22,918 | $383,970 |
| 1929 | 22,053 | $190,156 |
| 1930 | 25,006 | $249,765 |
| 1931 | 16,080 | $143,969 |
| 1932 | 12,632 | $107,567 |
| 1933 | 21,306 | $166,630 |
| 1934 | 27,161 | $246,548 |
| 1935 | 34,415 | $350,846 |
| 1936 | 55,090 | $520,852 |
| 1937 | 67,958 | $659,111 |

Few estimates have been made as to the bentonite resources in Wyoming. However, the U.S. Geological Survey in 1992 reported a wide range of estimates from various sources. These varied from a low of 91 million metric tons to a high of 1,846 million metric tons. About 166 million metric tons (183 million short tons) have been mined from Wyoming during the period 1920 through 2012 (fig. 1). Any reasonable estimate of remaining resources must include a variety of factors such as deposit quality, bed thickness, overburden, and accessibility. However, these estimates indicate that Wyoming likely has resources sufficient enough to last for many future decades. According to the Wyoming Business Report, during 2008 and 2009, the bentonite industry experienced a major setback of about 40 percent, primarily due to a global recession and cuts in steel production. The effect was very pronounced because 2007 was a peak production year. The follow-up recovery was dramatic because of the revived demand for drilling mud in the U.S, Middle East and the Pacific Rim.

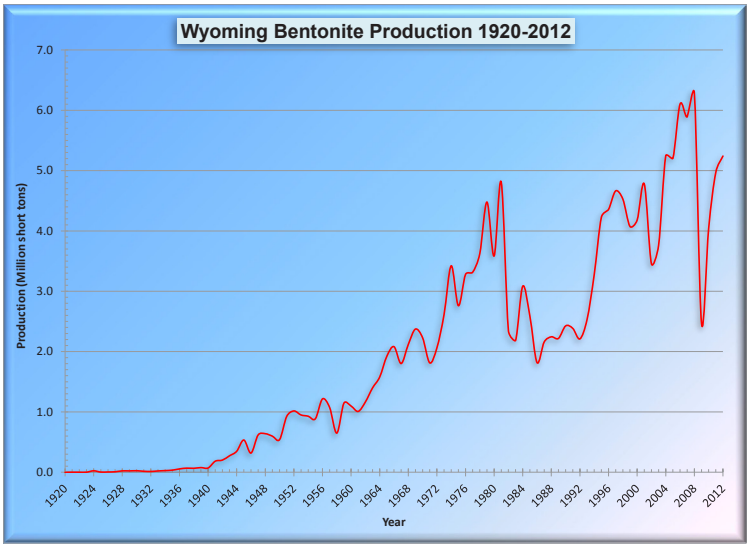


**Figure 1.** Wyoming bentonite production, from 1921-2012. *Graphic by James R. Rodgers, WSGS.*

## Bentonite Production History

The first bentonite production, at $25 per ton, was in 1888 by William Taylor from a property near Rock Creek. From 1888 through 1895, Taylor shipped 5,400 tons of bentonite from the quarry to buyers across the country. The price remained stable until 1896, when purchasers refused to pay more than $5 per ton.

In 1897, a bentonite pit was opened near Newcastle and Wyoming's total output for the year amounted to 150 tons. From 1898 through 1901, production averaged about 60 tons per year, rising dramatically to 1,200 tons in 1902. In 1919, approximately 25 railcars [volume unknown] were shipped from Wyoming and the price increased to $7 per ton. Around 1920, the first drying, grinding, and sacking plant was established in Cheyenne to process crude mine output from the Medicine Bow area.

According to the WSGS, bentonite production from 1921 to 1937 showed a substantial overall increase in both volume and total value (Table 1; Heathman, 1939). The major jump in production in 1928 resulted from the establishment of several new mills in 1926 in Upton, Osage, and Newcastle, along with the development of new markets and uses for bentonite. Six companies were operating mills in Wyoming in 1929. In 1939, bentonite production occurred in only two areas: around Newcastle in the Black Hills and in the Bighorn Basin northwest of Greybull.

In 1988, nearly 75 percent of all U.S. bentonite production came from Wyoming (Hosterman and Patterson, 1992). A continuing trend since 2012, Wyoming has led the nation in bentonite production, mining more than 5.2 million tons in 2012 by six companies and employing 777 workers. When compared to figures from the U.S. Geological Survey, this production represents well over 90 percent of all bentonite mined in the United States and 48 percent of the world's total production. Bentonite is also

produced in Greece, Brazil, Turkey, Germany, Czech Republic, Ukraine, Italy, Spain, and Mexico.

## Uses

Wyoming bentonite has been called "the clay of 1,000 uses," and is unique because of its high absorption and swelling rate. Bentonite is widely used in drilling mud for the development of oil and gas resources. Correlating with the boom in the oil and gas industry in 2005, the use of bentonite as drilling mud also increased. In addition to its industrial uses, bentonite is used as an absorbent such as cat litter, as a sealer for irrigation ditches and reservoirs, for pelletizing iron ore, as a bonding in foundry sand, and in pharmaceuticals.

American Indians recognized its use for natural healing. Legends indicate that medicine men in the Bighorn Mountains used what was considered a miraculous natural clay called "ee-wah-kee," or "the mud that heals." Pioneers also made use of "soap holes" in bentonite outcrops to lubricate wagon wheels and to wash clothes.

The first known historical use of bentonite was by teamsters and cavalrymen at Rock Creek (Albany County) when it served as a shipping point for frontier army posts. At the time, it was used as a substitute for soap for washing and as hoof packing for horses, to relieve soreness and lameness.

Today, bentonite is also used in petroleum and cement products, ceramics, refractory materials, paper, cosmetics, water softeners, sealing agents, paints, medical emulsions, and roofing.

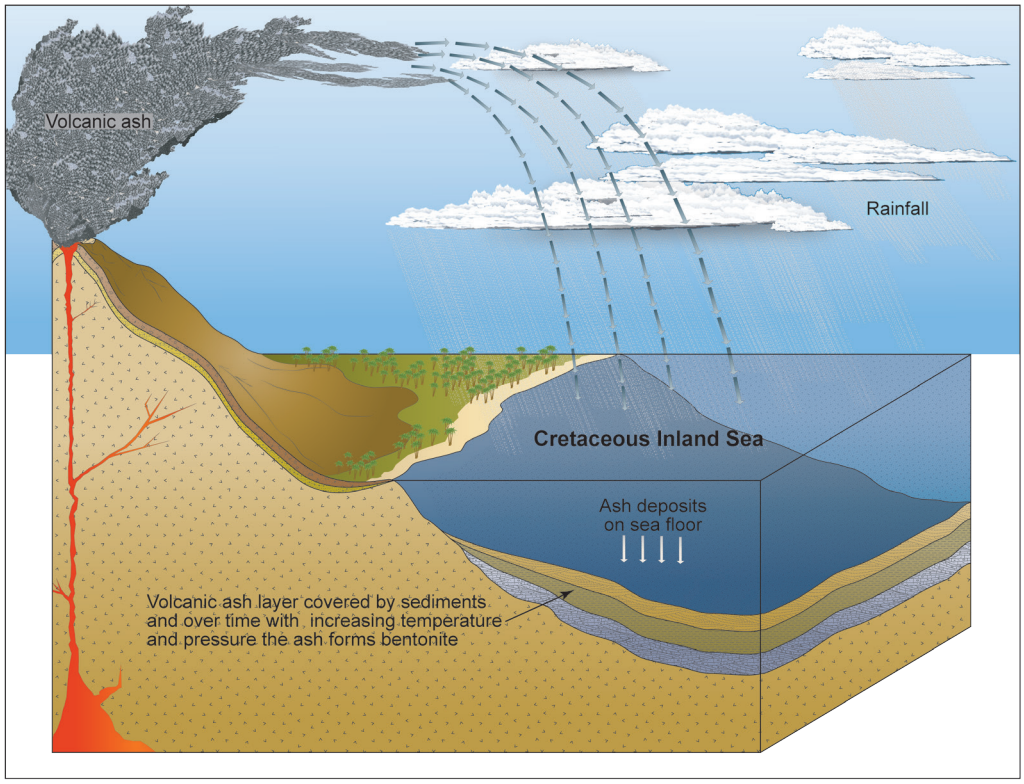


**Figure 2.** Wyoming bentonite formed by the decomposition of volcanic ash deposited millions of years ago in an ancient inland seaway. *Graphic by James R. Rodgers, WSGS.*

**Wyoming bentonite (also known as sodium bentonite) can swell up to 16 times its original size and absorb up to 10 times its weight in water.**

## Wyoming Companies

American Colloid Company (Lovell), Bentonite Performance Minerals, L.L.C. (Lovell), Black Hills Bentonite (Mills, Kaycee, Tensleep, Hulett, Newcastle), MI SWACO a Schlumberger Company (Greybull), U.S. Bentonite Processing, Inc. (Casper),Wyo-Ben, Inc. (Thermopolis).

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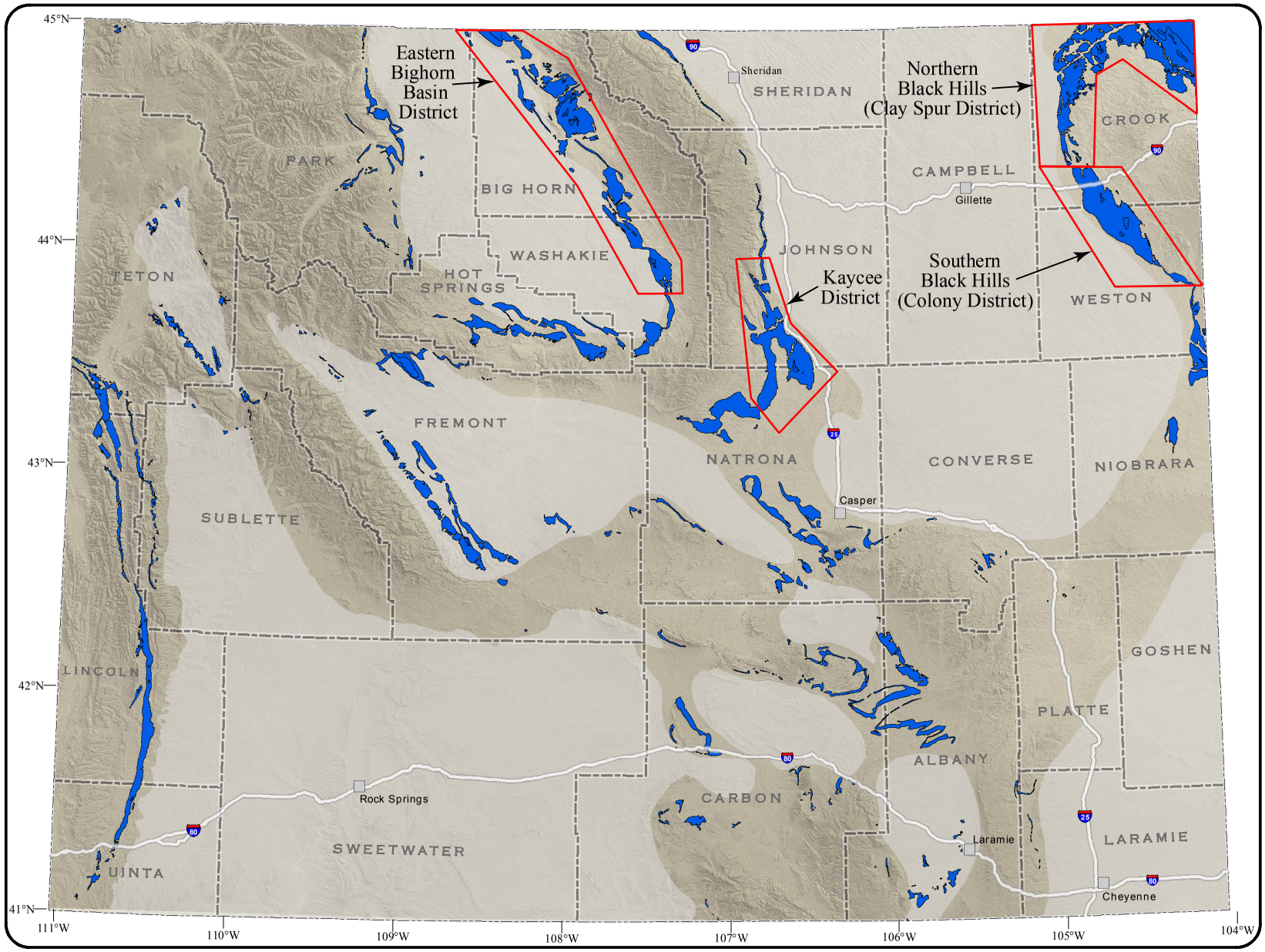
*Geology - Interpreting the past - Providing for the future*




Map design by Phyllis Ranz, layout by James Rodgers 9/2014.

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