Gypsum in Kansas

by

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Vol V. Geological Survey of Kansas.

The Kansas gypsum deposits of economic value form a belt lying northeast and southwest across the state. This area of exposed rock is two hundred miles long, and varies in width from five miles at the northern end to twenty-five miles at the central part, and one hundred and forty miles at the southern end. This belt naturally divides itself into three districts.

(1) The northern or Blue Rapids area, in Marshall County.

(2) The central or Gypsum City area, in Dickinson and Saline Counties.

(3) The southern or Medicine Lodge areas in Barber and Commanche Counties. These areas seem to be well separated, but careful investigation shows that there are a number of intermediate deposits which serve to connect these areas. Such connecting links are found in the reservoir excavation at Manhattan in Riley County, and at Longford in Clay County. Other deposits are found near Peabody and Burns in Marion County

Mulvane in Sedgwick County, and Geuda Springs in Sumner County.

In the spring of 1857 Thos. C. Palmer came from Ohio and camped on the bank of the Blue River near where Fowler's mills are located. He used several of the native whitish rocks to hold up his campfire. When they became cold again he found that they had slaked like lime. Thus was discovered what is now the great industry of Blue Rapids. He afterwards made a crude sort of plaster to use on his cabin. In 1858 Gen. Frank Marshall built his home in Marysville. It is standing to-day, and some of the first plaster made in Kansas from Kansas gypsum may be seen on its walls. The first gypsum mill was built in Blue Rapids by J. V. Coon in 1872. This was a shed on the east bank of the river. In 1875 he built a stone mill and the water power was used for grinding. This mill is standing to-day, a monument to the commencement of a great Kansas industry. In 1887 the Fowler Brothers formed the Blue Rapids company and in

1890 the Blue Valley company was formed, with A. E. Winter as manager. The Great Western company began work in 1895, and another mill will soon be built on the Yarrick farm south of town.

The Kansas gypsum deposits early attracted the attention of the geologists. This state has been noted for its geological questions, especially those concerning the Permain formations. Prof. Swallow in 1858 was the first to announce the discovery of Permain rocks and fossils. Since then the work has been well discussed and investigated. Our knowledge has been greatly increased by the work of Swallow, Hawn, Meek, Hayden, Newberry, Mudge, Hay, Cragin and especially Prosser, who made a section of the Kansas Permain formations, dividing it into four divisions - Cretaceous, Upper Permain, Lower Permain and Upper Coal Measures. The oldest geological formation is the Mississippi or Sub-carboniferous series of rocks covering a few square miles in the southeastern part of the state and then the middle

part are the Permain Strata. In 1864 the Annual Register stated that there were large deposits of gypsum of excellent quality west of Ft. Riley and also along the Blue River.

The deposits of the northern area rest on a nearly level floor of limestone, which dips toward the west at a small angle. The stratum is solid and undamaged. The upper surface is very irregular showing that much has been removed since its formation. This uneven surface is best shown in the Great Western Mine, where the gypsum lies in rounded masses with the long direction parallel to the hill slope. Much has been carried away by circulation of underground waters and by erosion. The layers of gypsum are from eight to nine feet thick.

The central gypsum rock rests upon shales, and dips towards the west. It is of greater thickness than the gypsum of the northern area and is covered with sandy shales. In the central part of this area the gypsum is compact the lower

portions contain the small selenite oval shaped crystals, which gives the rocks a spotted appearance.

The gypsum of the southern area is from twenty to thirty feet thick and extends on into Oklahoma and Texas. It is found in the Red Beds. It forms the caps of the hills near Medicine Lodge, but farther west it is covered by red sandy shales, and these same shales are found below the gypsum, also strata of sandstone of various thickness are found in the lower shales. The gypsum is compact and pure. The caves, natural bridges, and irregular upper surfaces, as well as the selenite layers below, give evidence of great removal thru solution. The older deposits are found in the north and the newer ones in the south. They are lower at the north and higher at the south.

Gypsum is one of the softest minerals, and in Mohs scale of hardness it ranks as number two, with a specific gravity of two and thirty two hundredths. It crystallizes in the monoclinic system

in the form of plates or prisms with pyramidal terminations. United twinned crystals are usually very common. It has a high cleavage and is only slightly soluble in water, the maximum solubility is found at 100° F. and then only one part of gypsum dissolves in three hundred and sixty eight parts of water.

There are five varieties of gypsum.

First,- Earthy gypsum, of yellow or gray color, composed of loose particles, which are light in weight, and formed by the precipitation from solutions of gypsum in water.

Second,- Compact or massive gypsum, including alabaster and gypsum rock. It is very soft, the typical composition being 32½% of lime, 46½ % of sulphuric acid, and 21% of water.

Third,- Fibrous gypsum or satin spar, which is usually found in thin layers in the form of fine needles or prisms.

Fourth,- Foliated gypsum, which is in round or concretionary masses.

Fifth,- Star anhydrite or selenite

which is found in transparent plates or crystals.

Gypsum has been deposited by the evaporation of sea water in inclosed lakes or bays which have been cut off from the ocean. Gypsum is deposited when 37% of the water has been removed. Salt does not deposit until 93% of the water has been evaporated. Thus the gypsum deposits are more widespread than those of salt, but are usually thinner.

Gypsum may also be deposited by some thermal springs where it is formed by the decomposition of volcanic tufa by acids dissolved in water. The sulphurous acid becomes oxidized to sulphuric acid, and then converts the carbonates into sulphates. Thru the evaporation the sulphate of lime is deposited forming layers of fibrous and selenitic gypsum.

Dawson thinks that there was first an accumulation of many thin layers of limestone, in which the organic materials were not excluded except

in the upper layers, and then there was an introduction of sulphuric acid, obtained as a product of volcanic action, then for a long time the acid water acted on the calcareous material until it was changed to a sulphate. Thus gypsum of a good quality and considerable thickness accumulated.

Pyrites or iron sulphide may change the carbonate of lime to gypsum, but this is only found in small amounts.

The Kansas gypsum is formed by evaporation. Thru some disturbance an arm of the sea was cut off at least for a time. In the northern part the gypsum is underlaid with limestone and contains clay seams irregularly distributed, showing that the area received drainage, which lasted until eight or nine feet of gypsum were deposited. Then the connection with the sea seems to have been restored again, and the sediment was deposited. After this, the gypsum of central Kansas was formed. This is almost free from clay seams, but intercalated with shale beds affording good evidences of alternat-

ing conditions favorable for gypsum formation and sedimentation. In the southern part of the state, after the central area had been raised to land, shallow water conditions prevailed. Thick deposits of shales were laid down interrupted for a time while the massive gypsum was formed. This gypsum has no clay seams, and is compact and pure.

The deposits of earthy gypsum in the central part of the state were formed at a much later period than the rock gypsum. They occur in low swampy ground and strong springs of gypsum water occur in nearly all of them. Gypsum in the form resembling satin spar and in an earthy form is deposited at the present time in dry weather to the extent of one half inch in a few days, by the evaporation of running water along channels near these places. Sand, clay, lime, and some organic material are found in small amounts in these deposits. The microscopical crystals of gypsum in this earth are angular but many of them perfect

Spring's theory is that the gypsum earth is deposited from solutions. The water circulating thru or near the underlying gypsum rock dissolved a portion of it and carried it upward in the springs to the surface, where the mineral was precipitated by evaporation aided by the action of organic matter of decaying vegetation. A crust of gypsum would thus be formed and would increase until all the underlaid rock was removed.

The symbol for gypsum is $CaSO_4 \cdot 2H_2O$. From this it is evident that the theoretical composition is 32.6% of lime, 46.5% of sulphur trioxide, and 20.9% of water. Practically there is always some impurity in the rock, so that all grades of material are found.

In analyzing gypsum two grams of the substance are used and dissolved in hydrochloric acid, and then evaporated to dryness to render the silica insoluble. Then it is dissolved again in dilute hydrochloric acid. The silica is then removed, and the filtrate is diluted to [illegible]

dred cubic centimeters. Two hundred cubic centimeters are used for the determination of the bases, and two hundred cubic centimeters for sulphuric acid. The presence of water can be determined either by heating in an air bath at 200°C to constant weight, or directly over a lamp turned so low that there shall be no danger of driving of carbon dioxide. Specimens of gypsum rock have been analyzed from Blue Rapids, Hope, Dillon, Medicine Lodge, and Solomon, and of gypsite or gypsum earth from Dillon, Rhodes, Salina, Gypsum City, Longford, Mulvane, and Burns. Then considering the average compositions of the materials analyzed there 20.71% of impurities in the materials.

The process of manufacture of plaster is quite simple, but is a very efficient one. On the ground floor of the mill are placed the "crusher" and the "nipper". The crusher has jaws of chilled iron, which have a backward and forward crushing motion. Blocks weighing fifty pounds are crushed to the size of

manic hand. These masses then drop into the nipper, which is set below the crusher. This machine has an interior revolving shaft which works like a coffee mill and crushes the gypsum into fine gravel. It is then raised in the buckets of the chain elevator to a bin on the second floor. From this bin the particles pass thru a spout into a buhr mill where it is ground as fine as flour. Then it passes into another chain elevator and is carried to the top of the second story into the storage bin located just over the kettle. It runs slowly from the bin into the calcining kettle, which is kept at a temperature of 212° F or over. These kettles are made of steel three eights of an inch thick, are usually eight feet in diameter, and from six to eight feet deep. They are set on a stone or brick base, and surrounded by a wall of stone two feet thick with an air space between. The kettle bottom is convex upward. Such a kettle will hold seven and one half tons of ground rock or gypsum earth. To keep it from burning the workmen

is constantly stirred on the bottom of the kettle by revolving arms with disks fastened to them. These arms are attached to a four-inch vertical shaft which is driven by a five-foot horizontal crown wheel set in motion by a one-foot vertical pinion wheel attached to the power shaft. It takes from ten to twenty-five horse power to run this stirrer, which makes about fifteen revolutions per minute. The kettle has from two to four flues. The heat comes up under the kettle and passes thru the air space at the side, and then thru the flues out into the air space on the other side and out thru the chimney. An hour after the kettle is filled the temperature reaches 230°F and the mass boils vigorously as the water is driven off. When the temperature reaches 270°F. the gypsum settles down solid, and at 290°F. it boils again. When a temperature of 350°F is reached the plaster is drawn off thru a gate at the bottom of the kettle into a fireproof bin. The whole process takes from two to two

and one half hours, and there is a loss of weight of 20% due to the loss of water. Three kettles are usually burned in a day and require one thousand and four hundred pounds of the best coal. Poor coals do not give sufficient heat even if used in large quantities. The temperature of burning is very important. if overburned the plaster sets slowly and if not burned enough it will not set at all. Then the gypsum is cooled. The best method is the suction pipe method. A sheet iron pipe ten or twelve inches in diameter has a strong current of air forced up thru it. The lower end of the pipe is of a telescopic character so that it can be lengthened downward at will. The mouth of the pipe is placed over the center of the upper surface of the hot plaster. The air currents suck in the hot particles and carry them to the desired height. During the process of manufacture a retarder is often added, to delay the time of setting of the plaster. Rock gypsum needs a retarder, but gypsum earth does not as it has enough

organic material and clay with it to delay the setting process. Plaster without the retarder will set in from six to ten minutes, but a retarder can hold back the set for five or six hours. Many substances have been used as retarders such as glue water, citric acid, etc. At present patent retarders are used, known as the Challenge, Lola, Webster City, etc, and also the organic material of tankage from packing houses has been found to bring about the desired results. The exact influence of a retarder is not known, but it holds the water and seems to hinder the rapid crystalliga-tion of the plaster. The plaster is later mixed with hair or vegetable fiber, such as is used in common plastering. The calcined plaster which sets in a few minutes is known as "plaster of Paris". The plaster which sets slowly whether retarded or not is called "cement plaster".

Gypsum in its ground uncalcined state is used as a fertilizer. In Kansas in 1894 five hundred and sixty tons out of sixteen thousand were used for

this purpose. The use of gypsum as a fertilizer is very old, in all probability older than the making of plaster of Paris. Virgil writes that impure gypsum was used by the early farmers of Britain and Lombardy. It is thot that gypsum acts as a fertilizer of soils in three ways:- one mechanical and two chemical

First.- Lime is known to collect the loose particles of the soil and make it more granular. It also has an opposite effect on the tough clay soils, where it granulates the particles and breaks it ups into finer pieces. Gypsum seems to act in both these ways to a certain extent.

Second.- It has been pointed out that gypsum has nearly one half its weight in oxygen and gives this up to many substances, and so may act upon nitrogenous and carbonaceous substances in the soil.

Third.- Gypsum decomposes the double silicates in the soil, setting potash free as a soluble sulphate. The potash solution reaches the roots

of the plants. In this state this feature has not attracted much attention because of the natural fertility of the soils. There are many old theories as to the action of gypsum on soils. Dr. Candolle's theory was that sulphate of lime acts as an irritant in favoring respiration and exhalation of plants. It is also thot that gypsum absorbs moisture readily, that it takes up the moisture in wet seasons and then gives it out again in dry seasons. Davy regarded gypsum as the direct source of plant food.

Plaster of Paris or partially dehydrated gypsum is used to plaster buildings. It gives a very beautiful white finish. It sets more rapidly than lime plaster and coloring matter can be added because the gypsum will not precipitate it. It is also desirable for filling of fireproof buildings, to deodorize foul air, to retard the fermentation and prevent the formation of too much free acid in wines, and also to absorb the water and strengthen the product. Surgeons use it for casts to hold broken limbs in

places and dentists to get the impression of the mouth. It is also used as molds for coins, pottery, and statuary.

There are three large mines and mills located at Blue Rapids, Kansas.

The Great Western Mine is located on the side of the bluff one mile north of Blue Rapids, and about fifty feet above the water in the river. The entry runs east and north and extends into the hill four hundred feet. The first two hundred feet of gypsum was in rounded masses, thick in the middle and running out on the sides. The gypsum rock at this mine possesses a sugary texture. The company has given it the name of crystal rock, on account of its loose texture and brilliant surfaces. Two miles west of Blue Rapids is the Winter Mine. The entry is fifteen feet above the water and runs east into the hill nine hundred feet. The double entry system of mining, with rooms sixteen feet square, is used here. There are twenty men employed and from forty to fifty tons of gypsum taken out in a day.

Fowler's mine is on the west side of the river on the edge of the town. The entry is fifteen feet above the river and runs east three hundred and fifty feet. Five men are employed at this mine, and in two days load a twenty five ton car and send it to the mill.

Six miles southwest of Solomon is located the mine and mill of the Crown Plaster Company. This mine was abandoned in 1898. The Kansas Cement Plaster Company, which has been in operation since 1887 is located at Hope. The "Agatite" Cement Plaster Company is located at Dillon. The greatest thickness of the gypsum at this place is eighteen feet.

The gypsum industry, altho it is very young is making rapid progress. The amount of gypsum exported is gradually becoming greater, but the price is remaining just about the same, altho the highest price paid per ton was in 1889, the price has reduced but slightly. The following statistics show the amount and value of gypsum produced in Kansas from 1889 to 1899

Year	Output in tons	Average price per ton	Value of Output
1889	17,332	$5.44	$ 94.235
1890	20,250	3.58	72,457
1891	40,217	4.01	161,322
1892	41,016	4.76	$195,197
1893	43,631	4.16	181,599
1894	64,889	4.65	301,884
1895	72,947	3.74	272,531
1896	49,435	3.00	148,371
1897	50,045	5.05	252,811
1898	39,776	3.26	129,652
1899	61,103	4.30	262,743

The Kansas cement plasters have finally made their way into almost all the markets of America. Some shipments go to New York, Boston, Minneapolis, New Orleans, and San Francisco, but most of the shipments are made to places west of Ohio.