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MR. W. D. WALTMAN,

Casper, Wyoming.

Dear Mr. Waltman:-

I have had a copy made of the only report upon the Sweetwater soda lakes, that I find at hand. It is by W. C. Knight, in one of the early Agricultural College reports.

I trust that it will be of some help to you.

Yours very truly,

State Geologist.

LWT/J

THE INDEPENDENCE GROUP OF DEPOSITS

This is the largest group in the state, and is located in the Sweetwater valley near Independence Rock, from which the group takes its name. The topography of this region is different from any other part of the state. The Sweetwater valley, which includes all of the territory between the Ferris mountains on the south and the Rattlesnake on the north, has an approximate width of thirty miles. This was at one time a level stretch of country covered with Tertiary rocks. The Sweetwater river in its meanderings has cut a broad irregular valley in the midst of this region. At the present time it is a comparatively level rolling country studded with low hills of granite, which are known as the Sweetwater mountains. These irregular masses of granite appear to have projected above the Tertiary seas, and at the present vary from one hundred to one thousand feet above the surrounding country. They are very smooth, nearly barren slopes, with occasional scrubby pine trees. Near Devil's Gate, which is just above the alkali deposits, the granitic mass is the largest, and crosses the river at this point in its southern course, and forms what has been known for years as Fort Ridge. From Fort Ridge to the northward the valley is quite wide, and there are numerous places where one can see the old river bed far to the north of the present stream. While the country about is composed solely of Tertiary light colored beds with the projecting knobs of granite, in the valley of the stream these are not visible. The surface of the valley is extremely sandy and there are small dunes scattered along the north side of the channel. Between the river and the alkali deposits, which are from one half of a mile to a mile north of the river there is a prominent divide that is covered with river gravel and sand. This divide extends for a distance of ten or twelve miles; but varies in prominence. Near Devil's Gate, this ridge terminates and the country is slightly higher than the valley to the south. It appears that the Sweetwater river at some early date occupied the depression north of the

ridge; but has not used it for a very long period of time. On account of the accumulation of sand, this old channel has numerous barriers across it, but as a rule one can trace the gradual descent to the eastward. At the present time none of the depressions have any connection with each other, and it is hardly probable that salts are carried from one to the other unless it is by underground drainage; which would be very natural in a sandy region of this sort. Along this old channel are scattered the alkali deposits. There is a very large one at the very head of the valley, and there are many small depressions that contain a crust of salt, or in a few instances some solid deposit to the depth of two or three inches. Where ever there is a depression, alkali is found to a greater or less degree. From the edge of the basins towrd the north or south there are typical alkali grasses which graduate into more nutritive forms on the sandy soil above. The depressions are apparently in a muddy layer, and above this there is quite a thickness of gravel and sand. Apparently the river cut this long channel out of the horizontal Tertiary rocks, and then partially refilled it with mud and sand. Later the stream abandoned it for the channel to the southward, and it was materially changed by the wind carrying sand, and also cutting away quite a volume from the various dry exposures. It looks very reasonable to believe that the wind has played a very important part in the development of the beds in which the alkali has been deposited. As has been found in all the alkali deposits, the beds beneath the solid crust are made up of a dark mud which is highly charged with the salts. Within the channel are located many of the most celebrated alkali deposits in the west.

North of this depression there is a second one, in which the Berthaton beds are located, thatvdoes not appear to have any connection with the one just described. It extends east and west for a distance of three or four miles, and in it there are numerous alkali ponds. It is probable that this also represents the old channel of the Sweetwater river; but the topography was not worked out in detail and this cannot be given as absolute. Otherwise

there is practically no difference in the appearence of the two channels.

The alkali deposits in the first channel are as follows:- New York, Philadelphia, Wilmington, Wilkesbarre and Omaha, besides many lesser ones of little importance.

The New York and Philadelphia claims are located on Section 12, Township 28, Range 87, and are very near the granatic exposures that extend north from Devil's Gate. These claims are located upon one basin, which according to survey of owners of these claims contain 110 acres of deposit. On the north the Sweetwater mountains rise to a height of about 800 fett. Otherwise the country is comparatively level. There is a marked outlet to the east and in case there is ever very much water in the depression there would be an overflow, into the numerous depressions along this old channel. The amount of alkali in this the largest deposit known in Wyoming was not estimated. In walking over the surface which was in places covered with mud, a solid mass was found everywhere, and since it was nearly a mile in length and from one fourth to one half a mile in width it would necessarily have to be quite thick in the center, probably from fifteen to twenty feet, and the entire deposit would average not less than four feet in thickness.

There are greater problems in connection with the origin of these deposits than any other in the state, and on this account it is best to make reference to some observations in connection with this great deposit. Where ever there are depressions in this vicinity, and about the large deposit, the alkali was found along the eastern sides, and reaching up to the grass roots, while along the western slope alkali was scarse or practically absent. In one place a spring of water was noticed to the westward of the old channel, and it was freely used by cattle and did not taste strongly of alkali. There was no marked amount of alkali collected along the north

side of the large deposit, which was nearest the granite. From what could be seen, it was evident that the alkali was being drawn from the north; but the source was not determined.

East of the New York and Philadelphia claims five miles are the Wilmington and Wilkesbarre, which are very near Independence Rock. These are located in Sections 2, 3, 10, and 11, T. 29, R. 86, being on a section line. The Wilmington claim contains 160 acres, and is a lake that has never been known to dry up. The water is highly charged with alkali, and possibly there may be salts forming in the bottom of the depression. The soil about is highly charged with alkali; but as in the beds above there is much more found to the north than to the south. The Wilkesbarre claim is only a short distance east of the Wilmington, and separated from it by a narrow ridge which is quite low. At the time of my examination the midst of this claim was partially wet and not being provided with waders I could not examine into the conditions beyond the limits of solid shore. The shore was covered with a thin efflorescent crust; but no deposit of any consequence was observed. As compared with the other deposits or claims this one is very small, and should there be a considerable deposit in the middle the small area would prevent it from being valuable.

About a mile and a half northeast of the Wilkesbarre claim is the Omaha; a very remarkable alkali deposit, although it is very small, containing only between three and four acres. The depression in which this claim is located is of considerable size and from the west and to some extent from the north there are efflorescent crusts of alkali leading down to the deposit. While the base of this depression is at least 50 feet above the Sweetwater river, the depression is nearly surrounded with a rim that is from 20 to 50 feet above the surface of the solid alkali. All of the surrounding surface could have been transported by the wind; in fact the soils are largely dune sands. The solid alkali

looks like a pond of glistening snow as one approaches it. The surface is comparatively level and the salts are as solid as a lake of ice. A drill hole put down in the middle of the deposit proved it to be four and one half feet in thickness. Owing to this deposit containing a large per cent of sodium carbonate and also some bi-carbonate it has long been used for cleansing purposes and to some extent for raising bread, and it must have been from this bed that the Mormons in the early days mined the alkali and transported it to Salt Lake.

From this place the surface of the valley falls very gently to the eastward, and there are many places where the soil is so completely saturated with the salts as to prevent the growth of any kind of vegetation. Even in the most favored places the only grass seen was the coarse, harsh variety that will grow upon alkali soil; but which the stock will not eat unless they are compelled to. These conditions extend as far down the stream as the Sweetwater bridge; here ditches are furnishing water for irrigation and portions of the valley are being successfully tilled.

North and east of the Omaha claim three miles are the Berthaton claims that have attracted considerable attention, and which are now being held by some Chicago gentlemen. Some years ago they erected a soda plant and commenced to manufacture the bicarbonate of soda. For unknown reasons the plant was shut down. These claims embrace 640 acres of ground that is scattered along what appears to be an old channel of the Sweetwater river. It is about three or four miles in length and drains into the river. The most of the depressions are covered with water and when making the examination one could not tell whether there was any solid soda deposited or not. The depressions were not separated by marked barriers as those to the southwest, and when any considerable water would flow into this valley, there is no question but they would drain one into the other and finally into the river. On this account there has never been an opportunity for any great accumulations of alkali. About this depression there was an

abundance of alkali efflorescence, much of the ground wasbarren and the remainder supported typical alkaline vegetation.

The origin of the alkali in the Independence group has has not been satisfactorily accounted for. If there is any alkali being produced by the decomposition of the granitic rocks, and stored in the soils, this appears to be an ideal place. The granitic hills are numerous and are often not far removed from the deposits. The river gravel is largely feldspathic granite and it appears that the decomposition of the feldspar in this should add a considerable alkali to the soils. On the other hand there was no evidence that the granite in place was feeding any of the depressions, and often a bank of river gravel was exppsed and no trace of alkali upon the surface. A vast amount of money has been spent in prospecting for supposed beds that many have contended were covered up, but without success. Holes dug tothe depth of 20 feet, in the various depressions, have universally proved to be devoid of any alkali, and often the water seeping into these prospect shafts has been fit to drink. Springs also occur in the vicinity of several of the deposits and usually the water is quite pure. In the vicinity of the Berthaton claims are numerous springs of very good water. All of the water used by the company developing these deposits was obtained from wells that were dug near by the soda deposits or lakes. This water was better than the average found in the Cretaceous rocks in Wyoming. Springs feed the lakes; but in my opinion they do not carry any considerable quantity of salts annually into the depressions. Judging from the fact that in the group nearest the river the efflorescent crust was found in abundance upon the soils and clays upon the east side of the depressions and only sparingly if at all on the western slopes, leads me to believe that the alkali is being brought in from the north by the seeping of water from rain or snow. It is clearly demonstrated that the salts are superficial, or they would be found in the many test pits that have been sunk. Whether or not they are found in any considerable

quantity in the Tertiary strata has not been determined; but I surmise that this is the case, and that they are being concentrated at the present time in the undrained depressions. The large amount of sodium carbonate present is a question that deserves attention; but since its occurance has hot been accounted for, it will not be taken up in this connection.

OMAHA DEPOSIT

A series of five samples were taken from this lake from the surface to a depth of about two feet in order to determine if there was any regular change in composition with the depth. The analysis shows no such regularity but on the contrary a great variation in the composition of the samples. The sodium sulphate is in one case nearly equal in amount to the carbonate; in another only one tenth as much. Chlorides range from one tenth of one per cent to seven per cent. In one the bicarbonate amounts to five per cent and in others is practically absent. The percentage of water increases with the depth, due to the top crust having lost part of its water of crystallization by efflorescence and the lower layers being not only fully hydrated but also soaked in the solution from which they were deposited. The insoluble matter which is mostly clay and sand, also increases with the depth.

Samples Nos. 76, 77, 78, 79 were taken from the Omaha deposit in 1897 and No. 148 in 1899 by Dr. W. C. Knight.

No. 79 is a surface sample from the Omaha deposit. It is partly effloresced and contains more sulphate and chloride than the other samples, as would be expected if we consider that it has been the last to crystallize and so carries the bulk of the impurities. It contains no iron, aluminum, calcium or nitrates, but traces of magnesium, borates and phosphates are present.

No. 78 was taken from just below No. 79 and represents the average mixture of salts to the depth of ten inches. No aluminum, iron or calcium, but traces of magnesium, phosphates and nitrates are present.

No. 77 is a deeper sample than No. 78 from ten to fourteen inches. It is lowest in sulphates and contains traces of lithium, potassium, magnesium, nitrates and phosphates.

No. 76 was taken from below No. 77, from fourteen to seventeen inches below the surface. The large amount of bicarbonate is remarkable. No iron or aluminum; traces of calcium, lithium,

potassium, phosphates and nitrates.

No. 148 was taken from the solid deposit at a depth of about two feet. Iron, aluminum, calcium, magnesium, lithium, nitrates, borates, phosphates were not detectable. Trace of potassium.

BERTHATON

The Berthaton deposit consists chiefly of sodium carbonate with a large amount of sodium sulphate and smaller amount of chloride. The composition of the two lakes is much the same, although there is a little bicarbonate in the small lake which does not appear in the larger. The water of the lake has the same salts in nearly the same proportion as the deposit, but the percentage of chloride and carbonate is a little greater.

No. 80 was taken from the surface of the small lake by W. C. Knight in 1897. It is a picked sample of clear crystals. There are traces of lithium, phosphates, nitrates, and magnesium.

No. 81 was taken from the large lake (Yale) by W. C. Knight in 1897 and was said to be representative of the best product of the deposits. No potassium, lithium or magnesium could be detected.

No. 84. The solution from the upper Berthaton Lake, taken by W. C. Knight in 1897. Its composition is as follows: stated in grams per liter, which is nearly the same as parts per thousand:

Sodium sulphate (Na_2SO_4)	17.26
Sodium chloride (NaCl)	11.69
Sodium carbonate (Na_2CO_3)	55.50
Total salts	84.45

The carbonic acid is here estimated by calculation, so the bocarbonate which must be present in a small amount is omitted.

THE NEW YORK AND PHILADELPHIA DEPOSIT.

A series of samples was taken from this deposit by W. C. Knight in November 1899, ragging from the surface to the depth of one foot, and analyses of these are given in the accompanying table. The salts are predominantly sodium sulphate but with a considerable proprtion of sodium carbonate and chloride in nearly the same amount.

No. 149 is a surface sample, No. 150 an average sample from just beneath the surface to a depth of four inches, and No. 151 is from four to twelve inches.

THE WILMINGTON LAKE.

The deposit along the shore of this lake (No. 152) shows the mixture of sulphate, chloride and carbonate characteristic of this group. A sample taken from the bottom of this lake (No. 153) is on the contrary nearly pure sodium sulphate with only a small quantity of chlorides. The water from the lake is a saturated solution of the salts with a specific gravity of 1.104 and has the following composition (No. 154) in grams per liter, which is approximately the same as parts per thousand:

Sodium sulphate	29.2
Sodium chloride	21.2
Sodium carbonate	69.3
Total salts	119.7

From these analyses it appears that the salt solutions that form these lakes deposit first pure crystals of mirabilite ($Na_2 SO_4 10 H_2O$) and afterwards a mixture of mirabilite crystals with increasingly greater proportions of sodium carbonate ($Na_2CO_3 10 H_2O$) and sodium chloride. There is no proof of the formation of double salts of definite composition, but further study by experimental fractional crystallization will alone decide this point.