From files of A. C. Boyle and Wyoming Geological Survey

NOTES ON THE ORIGIN OF GYPSITE Dated July 1927 —

The "Spring Theory of Origin" as described in L. C. Snider's "Report on the Gypsum, and Salt of Oklahoma" seems well suited in most respects to the evidence afforded by the gypsite beds. It seems to me well, however, to add to the outline therein given, some more detailed evidence in support of this general theory, and also to state some observed facts the reasons for which remain obscure.

The theory as stated in the Report is, in brief as follows:

> "The water circulating through, or near, the underlying gypsum rock dissolved a portion of the rock, and carried it upward in the springs to the surface of the swamp where the mineral was precipitated through evaporation aided by the action of organic matter of decaying vegetation."

The matter is certainly not as simple as might be indicated by this short statement.

For one thing gypsite is not found in cone-shaped masses such as are built up around the outlets of mineral bearing waters. "Secondary Gypsum" is found in that condition on mountain slopes in the dry climate districts of British Columbia. This is due to limestone waters being altered to gypsum waters, and leaching through the rocks, and evaporating in the dry air; but this action, and product are quite different from the typical gypsite of Oklahoma.

We also know that gypsum waters evaporating in red clays or shale - free of organic matter - will find cracks in the shale with fibrous gypsum, or if it has freedom, and a flat surface will form large clear selenite crystals.

On the other hand the chief characteristic of gypsite is not its impurity but its lack of crystallization, and its semi-plastic condition, due to some obscure condition of its origin.

I have not had the opportunity to examine gypsite under a high power microscope, but I firmly believe that the secret of its origin can best be determined in that way. It seems fairly clear that the nature of the deposited material is due to organic matter, and this will be referred to further on in this note.

A great deal has been written as to the relative position, and elevation of the surrounding gypsum rock to the gypsite. In other words (1) does the source supply of gypsum rock lie above the gypsite level - (2) does it lie on the gypsum level in the place of the original rock; or in the last case, (3) does it lie well below it with other strata between? The answer to the first two questions is "Yes". It is definitely, and repeatedly the case that the rock strata lies above the gypsite, and it is just as definitely known in some cases that the gypsite has the position of a former original gypsum strata. Naturally this condition is not so easy to make out as all of the rock may have been removed.

The answer to the last question, I think, is "No". It is not in the nature of gypsum rock to have ascending springs. Where they are found occasionally in gypsum districts the water appears to get its pressure from running in a cavern in limestone layers under the gypsum. For this reason, and also because of the fact that gypsum would not support the overlying layers if there was much solution -

except in the case of very heavy beds. I do not accept the theory of ascending waters coming from any considerable depth.

Let us consider the larger gypsite beds as they now appear. First it is noted that usually gypsite is found in a district of even slopes and not in a district of gullies, and hummocks. There are some exceptions - such as Roman Nose Canyor - but it holds true as a general rule.

The valley which holds a large bed has usually a basin-like form and a constricted drainage outlet. If the outlet is open, and free the amount of gypsite remaining is usually, but a small remnant of the original bed.

The gypsite seldom rests directly on any kind of rock but has usually a "cushion layer" of very fine-grained sand, or else a clay below it.

A curious thing about this under layer is that it is seldom dark with organic matter, but frequently red from iron oxide. And yet it frequently contains the bones of mammals. The bones I have seen suggest that they might be those of deer or antelope. I have not heard of heavy bones of pre-historic reptiles being found in gypsite, and in my opinion, the gypsite beds are of too recent origin to have them.

My suggestion, as a possible explanation, is that just previous to the formation of gypsite in these hollows that they were "salt licks". A certain amount of alkali would also be present.

In any case the animals went there, and left their well preserved bones for our inspection.

The gypsum rock layers would at that period probably closely border these hollows, and a large proportion of the rainfall would be taken in by cracks, and pot holes in the gypsum, and percolate underground, and come out finally in these hollows.

As a usual thing right below the gypsum rock was a few feet of shale - some times high in clay, and at other points in sand, or silica, and usually red. Below this there is usually a tight, flat, and massive bed of limestone or dolomite.

In my opinion, the larger part of the material found under the gypsite came from the shale layer below the gypsum, and also from clay streaks and "partings" within it.

The next condition appears to have been either a swamp with much vegetable growth; or else a series of ponds with sluggish drainage from one to another.

It might be well as a typical type for consideration to visualize a basin between ridges a mile apart. The whole floor of the basin is a marsh due to inferior drainage. The basin has two valleys or depressions leading into it at its upper end. Corresponding to the direction of these valleys, but in the main basin, are two series of connection ponds, which finally join near the outlet. These ponds are round or oval in outline - with a narrow passage connecting one with the next. They contain a high percentage of floating organic matter, and are surrounded by walls of what is commonly called "black muck".

If we can account for gypsite being deposited, and built up in the pond

portion of the marsh until it reached the general level we get a good picture of what the large gypsite beds now appear to show.

The general strike of the gypsite is usually a curving or slightly twisted line from the general direction of the entering valley or depression to the outlet. All the contours have been modified by recent erosion but the general fact is decernable.

The deep gypsite is bordered, and almost surrounded by walls of black or ash colored earth. This earth was much more easily eroded than the gypsite. The result was when the drainage became more rapid, and the water ran, they did so largely in the "deep Muck" portion and not in the gypsite.

This would account for several observed facts. The gypsite seldom goes to the edge of a basin, and seldom leans against the slope. There is usually a depression, and sometimes a pond in this position.

So true is this that the outline of a gypsite mass can be fairly accurately outlined by a study of these bordering depressions. It would also account for the gypsite being in the typical rounded or turtle-back ridges. They have a smooth outline, and they suggest that they were well washed by floods when the surrounding "muck" was carried away.

Taking it that this is the order of events the effects we now see in the drainage of these basins can be understood.

A lowering of the flow line of the main river of a district is followed by the lowering of the flow line of the creeks which enter it, and this action is carried further back year by year. The cultivation of land, and the cutting of trees tends to increase this action, and the effects are very noticeable in Oklahoma this year. When this action finally reaches one of these gypsite basins its appearance would quickly change. The old drainage in the series of ponds is now the most resistant part of the basin or valley. The amount of erosion in the gypsite will depend on the power of the stream during floods. The gypsite line is thin at some points, and may be broken through.

Finally the underlying flat limestone or dolomite strata is reached by the stream, and its position becomes more fixed. If the limestone floor is broken, and eroded out under the streams flow line then the remaining gypsite is left on a dry bench, and its erosion will be very slow.

This condition is repeatedly seen in Jackson, and Harmon Counties of Oklahoma in the more mature basins.

If there are two streams flowing into a basin the stronger one will break the limestone first, and become the major drainage and new lateral courses will form to correspond to its position.

We come now to the question of the organic matter in relation to the formation of typical gypsite. Beds can be found where the gypsum content is high but which are not typical gypsite, and have not the working qualities. These beds consist of minute crystals of selenite in a matrix of sand and clay.

The crystals can be seen to glisten in the sun - otherwise the material has the general look of gypsite to the casual observer. This material apparently has not received the organic treatment in the marsh necessary for the special gypsite qualities.

A very interesting question is whether or not some live organism had a part in this process or whether it is merely the chemical action of decayed vegetation.

The only direct evidence of life in the gypsite deposits are the scattered shells of Planorbis (snail). The calcium carbonate shown in analysis of gypsite is largely due to these shells.

The Planorbis snail beds of New Brunswick show in places a tonnage of 30,000 tons. The analysis shows this snail to be almost absolutely pure lime, and organic matter. The beds are formed largely of unbroken shells, and the source of the lime is clear springs issuing under the deeper portion of the deposit.

The borders of these bogs are generally black muck or else a mixture of peat, and muck.

As a further example of the action of organisms in building up mineral deposits take diatomite or diatomaceous earth.

In the east deposits are found in clear water lakes fed in the centre by springs. The best portion of the earth is in the zone half way between the springs and the shore.

One must magnify a thousand diameters to clearly see an individual diatom, yet they have built deposits of almost pure silica. In the east these deposits are in places ten feet deep, and still forming, while in California and Oregon they are measured by hundreds of feet.

We mention these cases to show that deposits can be formed in that way comparable in extent to the gypsite.

It is not suggested that we have evidence to show the same sort of action formed the gypsite. As far as I know there is not, and I do not think any other writer has mentioned this idea. I merely want this idea kept in mind for further study. It may be asked why does the gypsite deposit take a rounded form, and not show much evidence of stratification.

My answer is that it builds to itself from all sides if it has freedom to do so. If it built up by successive evaporation at the top it would show a stratified structure, and a pure layer would spread over a wide area, which is not the case.

It might be the wrong use of a term to call this concretionary action, and yet to my mind it is closely related to it.

It may be only that saturated gypsum water coming in contact with recently deposited gypsite tends to throw down its load at that point. In any case this curved structure is apparent at many points in the gypsite beds.

There is in all the soil mantle on the sides of a gypsite basin a percentage of gypsum, and in places on the lower slopes there is a gypsum clay mixture. The earth sparkling with minute gypsum crystals are found near or on top of rock gypsum strata.

In one gypsite district the bordering gypsum beds showed large sink holes, and caves - giving a source of underground gypsum water for the radius of

a mile or more from the centre of the gypsite bed.

It appears obvious that the nearby rock strata is the source of the gypsite, and personally I have yet to see a gypsite deposit too far removed from gypsum strata to make a question as to the source of the gypsum waters.

In one case the visible gypsum was nearly two miles distant but above, and on the same watershed. In other cases it was always nearer but not always apparent without careful search.

The future work on gypsite in my opinion should be to show the reactions in relation to organic matter by microscopic, and chemical study, and in that way a better synthetic gypsite plaster may be made.

Respectfully submitted,

(Signed) H. B. Bailey,
Geologist.

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