

ART. XXXI.—Spotted Lakes of Epsomite in Washington and British Columbia; by OLAF P. JENKINS.¹

Since April, 1916, large quantities of natural epsom salts have been mined and shipped from the so-called "Spotted Lakes"—two briny lakes, one in Washington and one in British Columbia. These lakes are both on Kruger Mountain, near the international boundary, and

FIG. 1.

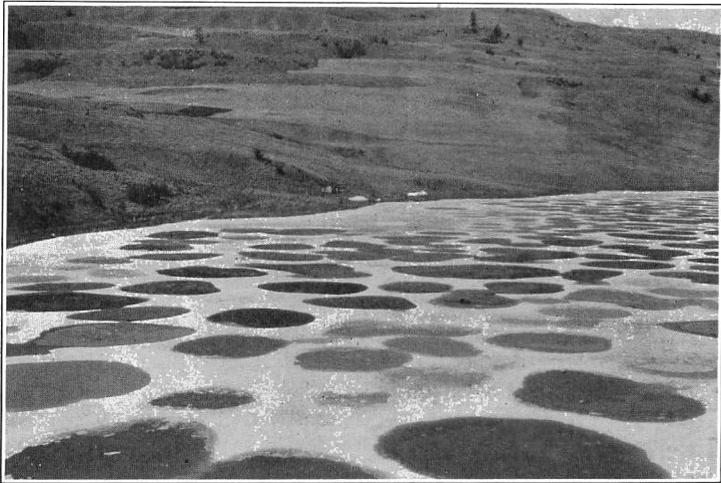


FIG. 1.—Large spotted epsomite lake in British Columbia, on Kruger Mountain. Photograph taken during the dry season in July, 1917.

within a few miles of each other, north of Oroville, Washington. The lakes have no outlets and the material occurs as a precipitation from the evaporation of waters saturated with magnesium sulphate. The mineral formed is *epsomite*, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$.

The accompanying figures show why these lakes are ordinarily described as being spotted. The dark spots represent shallow pools of brine, immediately beneath which are solid rock-like masses of epsomite. The areas between the dark spots are white because they are dry,

¹ This examination was made by the writer while engaged in work for the Washington State Geological Survey during the summer of 1917.

and a thin film of an efflorescence of these salts which covers them produces this appearance. Beneath this white film is mud, black, foul, and treacherous, which has been the cause of the miring of cattle in the past. During the rainy season the whole lake is covered with water, and then only a faint appearance of the circles is visible beneath the surface of the fresh water.

The smaller of these lakes, but the one more nearly devoid of any other mineral matter except magnesium

FIG. 2.



FIG. 2.—Small spotted epsomite lake north of Oroville, Washington. See explanatory cross-section, fig. 4.

sulphate, is in the state of Washington. It has an area of only four acres and a depth (determined by drilling) of 30 feet. It has gone by the names of Salts Lake, Poison Lake, Spotted Lake, and Bitter Lake. It is high up in the hills (1000 feet above Oroville, or 2000 feet above sea-level), in a little depression scooped out by former glacial action. It has no outlet whatever, and lies close to bed rock, which consists of metamorphic rocks, dolomites, and shales. Near by, but at a slightly higher elevation, are other smaller lakes or ponds of comparatively fresh water. In one of these is a deposit of marl, which contains many little fresh water shells.

The drainage of this basin region is less than half of a square mile, but in this area are numerous metalliferous mineral claims on deposits supposed to prove their value in copper content. The mineral deposits consist largely of pyrite and pyrrhotite bodies, and the presence of these, occurring in metamorphic magnesian rocks, suggests very pointedly the source and origin of the magnesium sulphate in the lake.

FIG. 3.

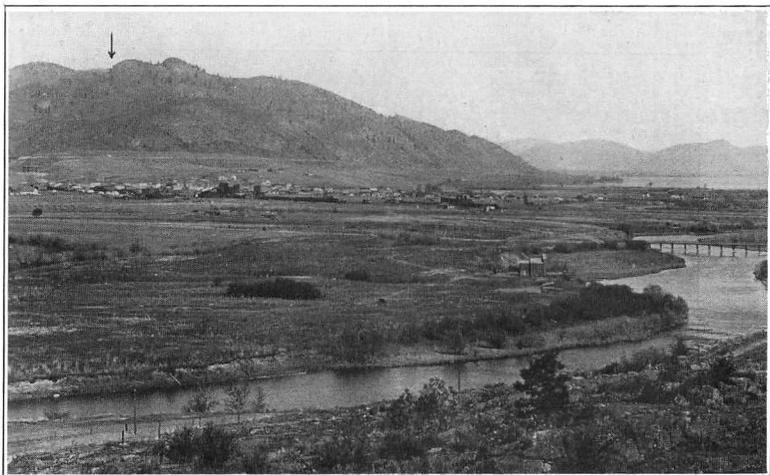


FIG. 3.—View of Oroville with Osoyoos Lake at the right, Okanogen River in the foreground, and Kruger Mountain in the background, with arrow pointing to situation of the small epsomite lake shown in fig. 2.

Not a vestige of visible organic life is left in this lake, but the black mud contains considerable decayed organic matter.

In mining the epsomite, first the solid salts were dug out of the spots or pools and hauled away. Later, water was obtained from a neighboring fresh-water lake, when not enough was to be had in the salts lake itself, and this was used to dissolve out the salts from beneath the mud, or from the pools where it was impracticable to get all the salts out by digging. The water was allowed to run down through holes in the mud, and was taken out by means of little gasoline pumps, sent back again through

other holes and pumped out again, until finally, when saturated it was piped to the salts plant on the railroad, over two miles away.

It was discovered, however, that the spots represented the base of inverted cone-shaped or cylindrical masses of salts, the tip of the cone being attached to a lower horizontal bed of solid epsomite beneath, in places as much as fifteen feet in thickness. This fact was important to those working the deposit, for it was found that

FIG. 4.

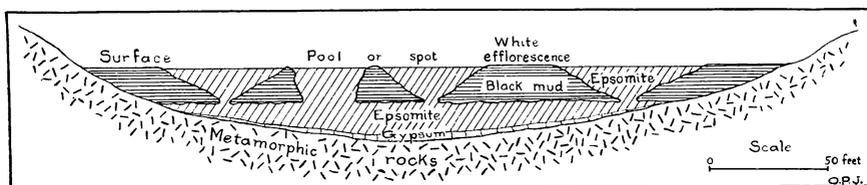


FIG. 4.—Hypothetical vertical cross-section to show structure of small epsomite lake north of Oroville, Washington.

this bed could be tunneled into and timbered, for the overlying black mud was quite impervious to water. The epsomite in this lower bed is in the form of large clear colorless crystals, some of which might be measured in feet. Upon exposure of this material to the air, a white frosted surface coating is formed, and it loses part of the water of crystallization, probably becoming the mineral *kieserite*, $MgSO_4 \cdot H_2O$. In time the whole mineral changes into this new substance. Sodium sulphate and other allied salts are practically absent.

In drilling to the bottom of the lake, when first prospecting, it was found that beneath the epsomite was a thin layer of gypsum, and between the gypsum and the bed rock was a thin layer of clayey material. The drilling was done because it was erroneously thought that the lake was in the crater of a volcano, and that it would have great depth.

In handling the salts at the plant, the operating company had to separate, when necessary, the included mud particles from the epsomite. This was done by dissolving, settling, and reprecipitation from a supersaturated solution caused by heating, evaporating, and then cooling the clear solution. Much of the material, however,

needed no further attention save pulverizing and packing. All of it was graded and packed in such a way that it would not deteriorate through loss of its water of crystallization. The reprecipitated crystals were dried first with a great deal of care.

The large lake, which lies in Canada, is about seventy acres in extent. Its depth and structure were not yet determined when the writer visited the place, but its surface appearance was much like that of the smaller lake.

FIG. 5.

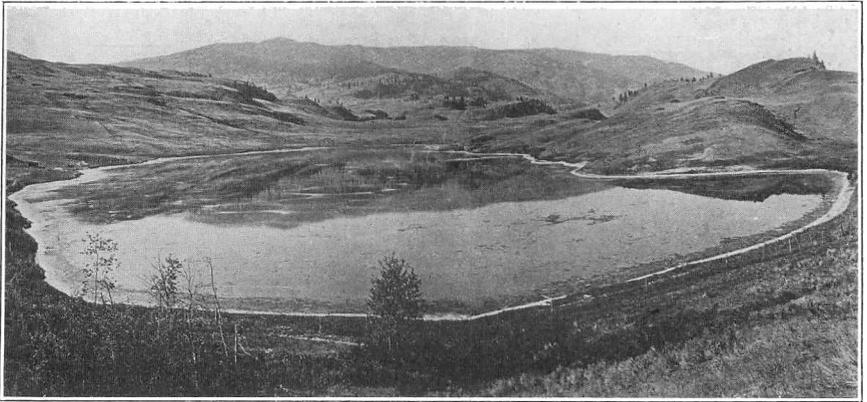


FIG. 5.—Same spotted lake as that in fig. 1. This photograph was taken after the rainy season.

At that time the first work was being done—that of removal of the salts from the shallow pools. The brine itself in the pools was so strong that it was very heavy and very slimy like the white of an egg, and had an offensive odor. The work was accomplished by shoveling the salts into wheelbarrows, wheeling them along planks laid down on the mud, and dumping their contents upon platforms on the shore.

The writer was told that seasonal changes, and even the daily changes of temperature, noticeably affect this lake. After the rainy season the spots are nearly hidden beneath the surface of the water covering. In the later part of the summer the brine of the lake is quite concentrated and during cool nights the salts crystallize out of the warmer daytime solution.

A peculiar form of algæ grows in this larger lake near the surface. A film of sodium sulphate is also present near the surface, which is absent in the other lake. Other briny lakes in this country were visited, and it was found that in most of these sodium sulphate predominated and also that extensive growth of algæ was noticeable. There is one such sodium sulphate lake within a short distance, just over the hill from this large epsomite lake. In some of these lakes faint traces of the spotted appearance could be detected in the arrangement of the mud beneath the surface of the water.

Discussion in regard to structure of the mineral deposit and to origin² and source of the material will necessarily have to be confined to the smaller lake in Washington, where the writer spent more time studying conditions. In this regard, let us go back to the description of this lake, and its surrounding territory. In addition to what was said, the pyrite and pyrrhotite deposits were oxidized to a depth of several feet from the surface to a mixture of iron oxides, quartz, clay, and tiny crystals of gypsum. Leading from these deposits to the lake were drainage ways, on the surface of which, in places, showed whitish alkali streaks.

These facts suggest the possibility that the sulphates and sulphuric acid, known to form from the oxidation of pyrite and pyrrhotite through the action of meteoric water and air, acted upon the dolomite and other magnesian rocks, forming magnesium sulphate, which is soluble, and calcium sulphate, which is much less soluble. The result was that the magnesium sulphate was carried to the lake in solution. What little calcium sulphate came with it was precipitated first, being less soluble, as a thin layer of gypsum over the sediment already deposited on the bottom of the lake.

This explains the formation of the horizontal layer of epsomite above the gypsum. The layer of mud on top of the epsomite layer is accounted for by the washing of sediment into the lake. The fresher water allowed some organic life to thrive, but with the increasing salinity of the lake, due to increased aridity, the organisms

² F. M. Handy: An investigation of the mineral deposits of northern Okanogan County, State College of Washington, Bulletin No. 100, Pullman, Wash. (Suggestion is made regarding the origin of the salts in the smaller lake, which coincides with the theory in the present paper.)

must have perished, and their decaying carbonaceous remains were added to the general clayey mass already accumulated.

The cones appear to have been formed by the gradual penetration of rising solutions from the lower layer and by its recrystallization in this newly acquired position. Each crystallization of the material helped to open up, by its expansion on forming crystals, a larger space, until the surface was reached. The appearance on the surface is that of circular bodies, or of spots when viewed from a distance.

The expanding force of the crystallization of magnesium sulphate is well illustrated at the salts plant. The operators state that at times during winter, after a sudden drop of temperature, a saturated solution, passing from tank to tank in a three-inch pipe, has crystallized with such force of expansion as to split the pipe from end to end. It was also found that the crystallizing salts could not be kept in wooden tanks, for the percolating solutions would work into the cracks and, upon crystallizing, would open up the joints between the boards, causing them to leak so that they had to be lined with metal.

The principal uses of epsomite are in medicine, in the tanning industry, and in the manufacture of various compounds of magnesium. It is artificially prepared elsewhere from dolomite and magnesite, and before the European war it was shipped to this country as a by-product of the potash industry in Germany.

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