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# TRAVERTINE DEPOSITS NEAR DURKEE

## Baker County, Oregon

**Introduction:** Hot springs have built rather extensive calcareous deposits on the banks of the Burnt River at the southern end of the Durkee Valley. These springs and their deposits have long been the object of much interest, both because of their general geologic occurrence and because of their possible economic worth. Although possible commercial outlets for calcium carbonate in this form are relatively limited in number at the present with the success of a quarrying operation here governed largely by the cost of shipping the raw material to the consummer, this department has conducted a survey to ascertain and record the various pertinent aspects of this occurrence. The following report consists of a description of the occurrence in which the potential tonnage and the geologic factors pertaining thereto have been set forth in as much detail as practicable short of actual proppect testing.

**Location:** The location of these deposits is at Nelson in the W½ of section 11, T.12 S., R.43 E., Baker County, and immediately adjacent to the west of the Nelson-Rye Valley road. U.S. Highway 30 and the Union Pacific railroad each lie within 1000 feet of the central-most cone of the group.

**Geology:** A comparatively large, recent cone with a well preserved, but currently inactive, spring exists as the most picturesque and impressive unit of this group. All other cones are remnants of geologically older deposits. For convenience in the subsequent discussion of potential tonnage these are numbered on the accompanying map. Deposit No. 5 is the most recent. Deposits Nos. 1, 2, and 6 are the oldest. Deposit No. 4 is of intermediate age.

The hot springs which formed these deposits have risen through a schist formation in which limestone lenses are abundant. This schist has been designated as the Burnt River schist by Gilully (in his Geology and Mineral Resources of the Baker Quadrangle, U.S.G.S. Bulletin 879) and assigned a tentative Pre-Tertiary age. It is, however, the limestone lenses associated with this formation, and not its age, which is of significance here, for undoubtedly this limestone provided the ascending hot waters with the calcium carbonate which they deposited at the surface.

Analysis has shown this bedrock limestone to be itself notably pure as follows:

| $CaCO_3$ % | $Al_2O_3$ % | $SiO_2$ % | $Fe_2O_3$ % | MgO % | Phosphorous % |
|---|---|---|---|---|---|
| 98.20 | 0.35 | 0.7 | 0.17 | 0.29 | 0.014 |

Only a few small limestone bodies are included within the boundaries of the map accompanying this report but large limestone masses* do occur in close proximity on both the easterly and westerly sides.

Other bedrock shown on the map is igneous. That occurring along the road in the lower left hand corner of the map is well exposed. It is highly crystalline and quite variable in texture and appearance. Petrographic study** of selected variations reveals it to be a porphyritic basalt showing several degrees of hydrothermal alteration. Large phenocrysts of plagioclase are common. This crystalline habit together with general field observations indicate the rock to be a dike or a very shallow intrusive.

The igneous rock which occurs on the very top margin of the map occurs only as float. Its abundance, however, suggests that rock in place is close. Two kinds of rock are to be seen here. The most conspicuous is dense, black, almost polished appearing boulders which range in size up to nearly 3 feet in diameter. Laboratory study shows that these boulders are fine grained basalts with amygdaloidal and vesicular structure. The amygdules are calcite with associated botryoidal limonite.

The other component of this igneous group is a buff-colored fine-grained porphyritic rhyolite. This rhyolite also occurs as float material in the form of small angular blocks. These blocks occur both intermixed with the basalt boulders and segregated on the uphill side of the slope from them.

A rather heavy soil mantle covers the area. Much of this appears to be a lake-bed material, probably not occurring as originally laid down, but more likely as wash or locally reworked material from initially higher elevations. This soil cover is mostly fine silt and loam with only occasional showings of coarser gravels.

This soil mantle effectively obscured both the lateral extent and thickness or depth of all the different travertine deposits. At the same time small outcrops of bedrock show conclusively that the contour of the bedrock surface governs the extent of each of the individual travertine deposits, both lateral extent and thickness. Yet nowhere does observable geologic critera afford data on the contour of this bedrock surface within sufficiently precise limits to justify its projection or any reasonable calculation of the probable tonnage of travertine in any of the individual occurrences.

In an effort to reduce this margin of uncertainty, the writer made, and has shown on the map, a distinction between areas of this soil mantle which showed notable concentrations of bedrock fragments and areas which were free of such bedrock indication. This procedure proved of value in further delineating the possible bounds of some of the deposits, but still it afforded insufficient control to warrant any calculation of reserves within reasonable bounds.

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For * ** see next page.

The relationship of this soil to the travertine deposits, and particularly to the older ones, is obscure. As has been pointed out, this soil overlies most of the deposits in variable degrees, but it probably exists as locally re-worked and re-deposited material washed from the adjacent hills. Whether or not the oldest travertine deposits rest directly on bedrock or on primary lake bed sediments is problematical. Drilling or comparable exploration will be necessary to establish the relationships.

Analysis of the travertine deposits is as follows:

| $CaCo_3$ % | $SiO_2$ % | $Al_2O_3$ % | MgO % | $Fe_2O_3$ % | MnO % | $TiO_2$ % | $ZrO_2$ % |
|---|---|---|---|---|---|---|---|
| 98.8 | 1.25 | 0.52 | 0.40 | 0.14 | 0.02 | 0.015 | 0.006 |

The sample from which this analysis was made consisted of several hundred small chips taken at frequent intervals from all exposures over the width and breadth of the property regardless of apparent local impurities.

Deposition of travertine today is essentially negligible as a few seepages represent the only evidence of hot spring activity. Water in the most recent crater stands about three feet below the rim. The temperature of this water was found to be 23° C on a day when the atmospheric temperature was 1° C.

That hot spring deposition has been in progress here for a considerable period of time has already been mentioned. While some comments have been made concerning the age of these deposits, the subject warrants amplification. The oldest cones were formed when Burnt River canyon was quite young, as their uneroded remnants are now 180 feet above the present river level. The most recent cone which still has water standing in its crater within a few feet of its rim was reportedly overflowing as late as 1920. It would in all probability be overflowing today were it not that several seepages have broken out at lower elevations on the hill. Specific evidence regarding the span of time between the earliest and latest deposition appears lacking, but several things suggest that this activity was in progress here for a very appreciable period of time. The extent of erosion of the older cones is one criterion. The section of deposit No. 1 in Fig. 1 illustrates this graphically. As may be seen the bulk of this deposit has been removed during the down-cutting of the river channel.

The character of the material which constitutes the deposits is in itself also indicative of their age. The oldest deposits are denser than either the intermediate or recent ones, and weigh approximately 148 pounds per cubic foot (1) as against 125 pounds per cubic foot for the material comprising the intermediate or No. 4 deposit. Although this difference in specific gravity alone does not prove the existence of an appreciable age differential between occurrences, it does reflect differing conditions of deposition which in themselves required considerable time to materialize. For example, the temperature of the water probably had much to do with the rate of deposition of travertine and consequently the specific gravity thereof to a large extent, and temperature changes undoubtedly did not occur rapidly.

(1) Determination made by Dr. W. D. Lowry.

* A large chip sample of the limestone body occurring in T.12 S., R. 43 E., sections 11 and 15.— analysis by Mr. L. L. Hoagland of this Department. All chemical analyses in this report were made by Mr. Hoagland.

** By Dr. W. D. Lowry of this Department. All petrographic studies quoted in this report were made by Dr. Lowry.

What the initial temperature of these springs was is of course open to question, but the present temperature is undoubtedly far lower than the original.

Potential Tonnage: The total area of exposed travertine outcrops is 290,000 square feet. Despite the detailed contour map made, this is the only reliable figure that can be offered here. A more comprehensive picture of the potential tonnage requires individual descriptions of the conditions prevailing in each deposit due to the extent to which the bounds and depth or thickness of each deposit is obscured. Such a description is made in the following paragraphs.

Deposits Nos. 1 and 2. These deposits represent remnants of old cones (refer to the section of deposit No. 1 in Fig 1). They each outcrop to form cliffs along the breaks of hills. These hills are, in reality, just relatively small mounds on the flank of a large and steep valley wall. The tops of these hills are gently rolling flats composed of the reworked lakebed soil mentioned in the foregoing paragraphs on geology. This soil covers the deposits to within a few feet of the cliff faces to make the outcrops of the travertine appear as ribbon-like patterns on the geologic map.

A talus of soil and fragmental travertine abuts against the face of the cliffs leaving a section of travertine, the exposed thickness of which is variable and difficult to measure. Likewise, no reliable evidence is apparent to show how deeply the true bases of the deposits are buried. Judging from the dimensions of large blocks of travertine which occur in the talus below these outcrops it would seem that the real thickness of these deposits is not greatly in excess of the apparent thickness of approximately 15 feet in the central portion of each, thinning gradually on the flanks.

The deposits dip into their respective hills at various angles ranging up to 15 degrees. How far back (westerly) on their hills these deposits extend depends largely upon the contour of the underlying bedrock. As is, bedrock(limestone schist and basalt)is to be found approximately 30 feet below the visible base of each deposit. That the bedrock rises to the west in general conformity with the surface contour is established by nearby outcrops. That bedrock may be essentially at the surface at the back (or western) portion of these hills near where the flats abut the eastern slope of deposits 3 and 4, is indicated by a sparse concentration of bedrock fragments in small areas of the soil overburden there. If these soil fragment indications are genuine reflections of the proximity of a bedrock outcrop there, then deposits No. 1 and 2 do not underlie the entire surface of the flat to coelesce with deposit No. 4. Clearly drilling or test pitting on these flats back of and above each of these rim rock exposures must necessarily be done to establish just how far back on these flats the travertine of these deposits does extend, and to establish its thickness there.

Certain calculations can be made on the observable and probable tonnage in both deposits No. 1 and No. 2. As can be seen on the map, the trace of the outcrops of these deposits bows back around their respective hills at each extremity. This condition does indicate an extension of these deposits back on the hills. It would seem safe to connect the two ends of each of these outcrops with a line, and figure the area between this line and the trace of the travertine-soil contact above the cliffs as underlain by travertine (probable ore). On that basis there is an inferred area of 14,700 and 28,900 square feet in deposits Nos. 1 and 2 respectively. The area of their outcrops is 7,800 and 18,000 square feet. The total of inferred and known area is 22,500 for No. 1 and 46,900 for No. 2. Assuming an arbitrary and conservative average thickness (allowing for marginal thinning) of 7 feet for each deposit, there is a total of 158,500 and 328,300 cubic feet in these remnants. At 148 pounds per cubic foot (the weight of these older deposits as already mentioned in the preceeding paragraphs in general geology) this is roughly 11,700 and 24,319 tons. Assuming an average thickness of 10 feet, the tonnage would be 16,666 and 34,740 respectively.

The average thickness of these deposits may well be even greater than 10 feet. Since the highest noted evidence of bedrock is approximately 30 feet below the visible base of the deposits, it is possible that a very considerable thickness of obscured travertine might be found here. In the last analysis the deposits will each have to be drilled, or pits will have to be sunk at intervals along the faces of the cliffs to reveal for measurement the base of the travertine before really significant calculations of tonnage may be made.

Deposits No. 3 and 6. Deposits Nos. 3 and 6 are like Nos. 1 and 2 in that they are remnants of older cones and composed of the denser travertine. Their extent and thickness, however, are even more obscure. No. 3 has considerable topographic expression in that the bulk of it constitutes a hill free of overburden, but only indirect evidence exists concerning thickness. Indications along the eroded crest suggest that the travertine might be only a few feet thick there, although indications along its base suggest that there may be much more thickening on the flanks. Between the road and the base of the deposit, there is an area of soil somewhat darker than the prevalent soil found on the flat between deposits 1, 3 and 2 and 4. This soil contains a few small fragments of schist. Although this could possibly be soil transported to its present location before deposition of the cone changed the topography, it is likely that this evidence reflects the proximity of the schist bedrock here. That this is probable is indicated by a similar occurrence of schist soil at approximately the same elevation, about 300 feet to the northwest and in the area between deposits 2 and 4.

The exposed area of deposit 3, including the narrow belt which extends down to and adjoins the side of No. 1 is 52,000 square feet. If the body of this cone (referring to the area above the road, 47,800 square feet) is solid travertine then there is a relatively large tonnage in this one deposit, as the difference in elevation between the high point and the observed base is about 45 feet. On the other hand, if the core of this cone is not travertine, then potential tonnage available here is small. A short distance up the hill (and to the west) from the high point of this deposit there is widespread evidence of bedrock, both schist and limestone. This shows conclusively that there is a rise in the underlying bedrock, but the distance between control points is too great to be of significance relative to the thickness of the deposit itself. Assuming the travertine occurs as a veneer on an average of five feet thick, the cubic feet available would be 239,000 or 17,700 tons. Assuming a solid body (which is not wholly probable), the tonnage would be many times greater.

Deposit 6 is the smallest deposit mapped. It appears to be a massive ledge of travertine about 20 feet thick. This occurrence shows no distinctive cone-like pattern as do the other deposits and schist fragments are to be found in the soil right up to the travertine, both above and below it. The schist soil immediately above the deposit is undoubtedly wash and slide material from the hill above. However, the abundant evidence of bedrock further up on the hill above the travertine, together with the steepness of the hill tends to indicate that the deposit is perched on a relatively small bench.

The surface area of the outcrop here is 14,400 square feet. With the cross section of the outcrop being approximately a right triangle, having the width of the outcrop for one side, the indicated 20-feet depth of the uphill side for another, and the slope of the hill for the third, there would be approximately 144,000 cubic feet of travertine in sight here. At 148 pounds per cubic foot, this is equivalent to 10,600 tons. It would seem safe to double this tonnage but how much more hidden reserve there may be cannot be estimated from the information at hand.

Deposits 4 and 5. The youngest deposits, Nos. 4 and 5, exhibit the largest showing of minable travertine, and they undoubtedly contain the largest potential reserve of all the deposits in the group.

As these deposits coalesce, or overlap, it is best to discuss them as a unit. The area of the combined measurable outcrop is nearly 200,000 square feet. Deposit 4 exists as a symmetrically formed cone. From its flat top to its base (travertine-soil contact) there is a difference of 55 to 60 feet. How far travertine persists in depth below this travertine-soil contact is unknown, but the indications of nearness of schist bedrock described in the discussion of deposits 1, 2 and 3, suggest that on the flanks of this cone at least, the distance to the real base is not great.

Deposit 5 overlaps onto 4 with the margin of 5 occurring on the flat top of 4. A distance of 35 feet exists between the base of 5 and the crater level to give a combined difference in elevation of 90 to 95 feet from the observable base of 4 to the crest of 5.

The question of the thickness of these deposits, or the depth to bedrock under their crests gives rise to two considerations, 1, the rate of rise of the underlying bedrock, and 2, the possibility that both of these deposits may occupy the channel of an old ravine.

Out crops of bedrock occur nearby on both flanks of these deposits beginning at elevations comparable to the crest of No. 4 and continuing to elevations much higher than the highest elevation of No. 5, and the indirect schist-soil indications ring deposit No. 5. From these observations it is evident that the regional bedrock profile is essentially the same as that of the land surface. Should a comparable bedrock profile prevail underneath the area occupied by deposits 4 and 5, then these particular deposits would rate as veneers and the tonnage involved in them is relatively limited. On the other hand, should these deposits occupy the site of a pre-travertine ravine, their aggregate tonnage might be quite substantial. That there is a possibility that such a pre-travertine ravine might exist here is to be inferred from the local drainage pattern. As can be seen on the map, a little draw runs directly up the hill in a westerly direction from the crater. Below these deposits a more prominent draw separates deposits 1 and 2. This draw also runs in a westerly direction. A line connecting these draws is clearly a projection of their trends, and with a slight arc, such a line passes directly through the central most portion of both of the deposits under discussion.

One small ravine having a trend corresponding to this possible pre-travertine ravine is to be seen on the extreme right hand side of the map. Others, some quite large and possessing similar trends, occur in close proximity to these deposits, but just off the bounds of the map. The fact that the trends of these present day ravines corresponds with that of the postulated ravine, may be considered as supportive evidence to the contention that such a pre-travertine ravine may exist beneath the deposits under discussion. A small deposition of travertine in the bottom of the ravine on the right hand side of the map also lends added weight to the supposition that these deposits (Nos. 4 and 5) may have accumulated in a similar ravine.

Another factor requiring consideration here to complete this discussion of the size of these deposits is the boundary of No. 5. As can be seen by the map, soil overburden covers much of the flat surrounding the crater, even coming to within a few feet of it on the back (or westerly) side. This soil covering the deposit is the yellow, silty soil which is free of bedrock fragments. Laterally, on the north, south, and west of the crater, and at the foot of the slopes of the hills surrounding the flat, fragments of schist do appear in this soil to form the first indication of a lateral boundary. Undoubtedly, this schist soil has migrated down from the surrounding hillsides. The extent to which these soils encroach upon the surface of deposit No. 5 can not be established with the data on hand, but it is reasonable to presume that the travertine may actually underlay a somewhat larger area than is indicated by the mapped boundary, particularly so to the west and southwest.

Because of the complete uncertainty of the third dimensional data no attempt is here made to calculate even possible tonnage as was done in the instance of the other deposits. Instead, reference is made to Figure 1, which gives a graphic portrayal of the possible extremes of occurrence of the bedrock profile beneath these the Nos. 4 and 5, deposits.

**Conclusion:** Hot spring activity over a period of geologically recent time has resulted in the deposition of several travertine bodies in the area covered by this report. Some of these deposits occur as individual ones, isolated from the rest, or at best only connected by means of an overlap of incidental proportions (Deposits Nos. 1 2, 3 and 6). Others (Nos. 4 and 5) coalesce and overlap to a considerable extent. Some of the deposits (Nos. 1 and 2 conspicuously so) represent remnants of cones, the bulk of which has been eroded and carried away by the river. Others (Nos. 4 and 5) are of ultra recent age and completely intact.

The nature of the occurrence of deposits 1 and 2 and probably also 3 and 6, is such as to restrict their individual extents to within fairly definable bounds insofar as their physical existence is concerned. Even though the lack of essential data renders it impossible to calculate their existent tonnages within reliable limits at this time, it is apparent that (a) their potential tonnage is governed by the fact that they represent a blanket-like veneer covering an old land surface, (b) they are subject to lateral thinning, (c) their maximum thickness (in the instance of Deposits Nos. 1 and 2 mostly) is probably not much in excess of their greatest exposed sections.

Deposits 4 and 5 represent uneroded, overlapping cones. Together they probably contain the largest body of travertine on the property from a tonnage standpoint. What this potential tonnage might be is a problematical quantity dependent upon whether or not these deposits occur as blanket-like veneers built upon a sloping bedrock profile in a manner similar to the other deposits, or if instead, they were accumulated in an early ravine. Certain factors combine to suggest that the latter may be the case. If this is so, the tonnage involved in this group may be quite appreciable.

Whereas geologic mapping served to provide the data from which the foregoing relationships were established, the lack of exposures of a sort that would provide pertinent information on the third dimension renders it impossible to make any estimate of "PROBABLE" travertine tonnage, or even any significantly reliable estimate of "POSSIBLE" tonnage. Drilling, or other prospect development work, will have to be done at several critical places in order to obtain the needed data. Whether or not expenditures for such work may be justified will depend upon whether or not a market can be found for the travertine. This aspect of the subject is beyond the scope of the present investigation, but considering the location of the property with reference to possible consumming markets, the low unit value commanded by non-mettalic ores of this type, and the physical nature of the material in this occurrence, it is apparent that careful analysis of all phases of industrial requirements and mining and transportation costs should be made before any appreciable expenditure is warranted.

<u>Appendix</u>: Since the map accompanying this report was made the river has been diverted to the west side of the railroad. The cut made for this purpose entailed a minor re-routing of the county road. This work revealed nothing new geologically, the material excavated being largely travertine talus and soil as mapped.

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