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A. W. Fahrenwald, Director

A REPORT ON GYPSUM DEPOSITS IN WASHINGTON COUNTY, IDAHO

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INTRODUCTION

The presence of gypsum along the lower Snake River in both Oregon and Idaho has been known for many years. The deposits on the Oregon side of the river were worked quite extensively from the middle 1890's until about 1924. Although the Idaho deposits have not been developed to the point of production, claims have been held on some of the area on which gypsum outcrops at least as far back as 1912.

After the end of World War II, the Northwest Gypsum Company of Colfax, Washington, obtained an option on claims covering much of the known gypsum on the Idaho side, and plans were advanced for the development of the properties. By the summer of 1951, some stripping and tunneling had been done, and a dirt road had been bulldozed to the deposits.

During the latter part of July, the Idaho Bureau of Mines and Geology investigated the area to obtain information on the nature of the deposits, and the type of operation which they might be able to support. This field work included locating the exposed gypsum bodies on a base map, and collecting representative samples which might be of help in determining their extent and origin.

The results of the field investigation and later examination of rock specimens are embodied in this report. As the primary purpose of the field investigation was to check on the various gypsum bodies, the general geology of the area has not been treated.

ACKNOWLEDGMENTS

Through the courtesy of the Idaho Power Company, Mr. M. L. Bartlett of their Boise staff acted ably as plane-table surveyor, and also drafted the base map. Mr. Fred Still of Payette, who holds claims on part of the area, was of much assistance in examining the development work which had been carried out by the company. Mr. S. M. Barton, Consulting Engineer of Boise, who holds claims adjacent to those optioned to the Northwest Gypsum Company, provided us with aerial photographs of the area, and assisted in obtaining maps which were of value. Dr. C. T. Bressler, Department of Geology, University of Idaho, examined the thin sections of rocks collected in the area, and was of great help in determining their nature and composition.

PREVIOUS WORK

In 1923, the Idaho Bureau of Mines and Geology published Pamphlet #13 by D. C. Livingston, entitled "A Geological Reconnaissance of the Mineral and Cuddy Mountain Mining District, Washington and Adams Counties, Idaho". In addition to the actual mining districts, this report includes a reconnaissance of the area immediately adjacent to the Snake River for some 50 miles between Burnt River on the south and Indian Creek on the north. Thus it covers in a general way the gypsum deposits with which this report is concerned.

In 1946, N. S. Wagner of the Oregon State Department of Geology and Mineral Industries, examined the old gypsum mine which is near Gypsum, Oregon, about four miles to the south of the Idaho deposits. He has provided the Idaho Bureau of Mines and Geology with a copy of the report which he prepared at that time.

The deposits have been noted in many of the comprehensive references on

gypsum, generally being tied in with the more actively exploited deposits on the west side of the river. However, no detailed work has been published dealing with either group of deposits.

LOCATION AND DESCRIPTION OF THE AREA

The deposits are located in Sections 7, 8, 17, 18 and 20, Township 13 N., Range 7 W., Boise Meridian, Washington County, Idaho. Sections 7 and 8 are cut by the Snake River which flows north toward the Hell's Canyon region. The area is about 7 air miles north of the point at which the Portland-Pocatello line of the Union Pacific Railroad crosses the Snake River, and is 20 air miles northwest of Weiser, Idaho.

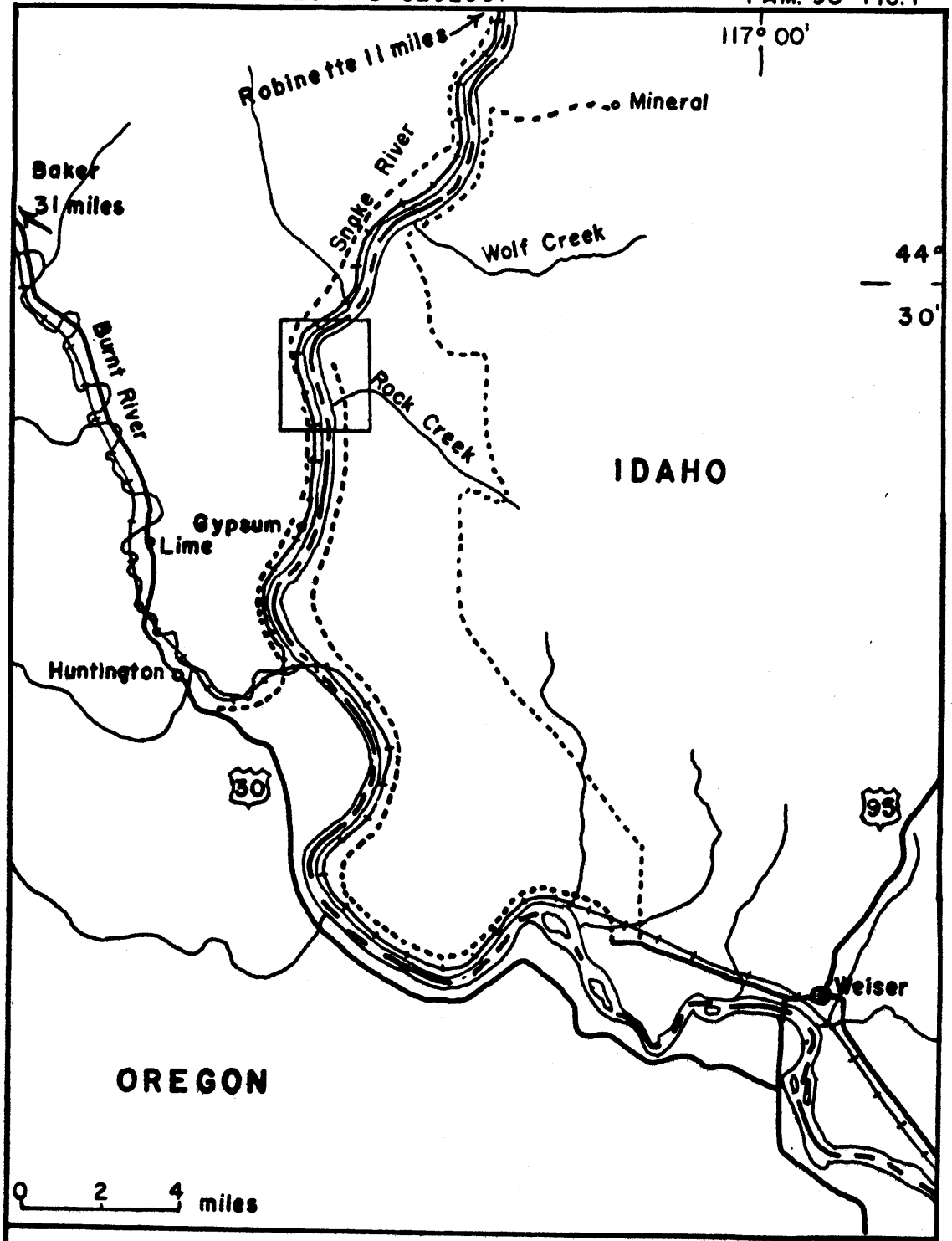
By road, the deposits are about 30 miles from Weiser. The last 18 miles of this road were bulldozed in to the deposits during the winter of 1950-51. This section of the road is suitable for light traffic during the dry season. An adequate road for moving in equipment and for handling heavy trucks could be built using most of the present roadbed.

A good gravel road, and the Robinette branch of the Union Pacific Railroad run along the Oregon side of the river opposite the deposits. Before the building of the road on the Idaho side, access to the deposits was had by ferrying across the river.

The location of transportation facilities which serve the area are shown on Fig. 1.

In this area, the Snake River flows north through a relatively narrow valley, the floor of which is at an elevation of about 2000 feet. The hills rise steeply but not abruptly as one moves away from the river, so that in places there is a rise of over 1000 feet within a mile of the river.

At some points on both the Idaho and Oregon sides, the valley is wide enough to allow for narrow farms. For the most part, the area away from the



LOCATION MAP
WASHINGTON COUNTY GYPSUM DEPOSITS

AREA COVERED BY DETAIL MAP (FIG. 2)

PAVED ROADS ..... OTHER ROADS +—+ RAILROADS

river is used as range land, and the remains of abandoned farm buildings indicate that only in selected localities can more diversified agriculture be supported. The hills are covered with a low coarse vegetation, and rock outcroppings are relatively few.

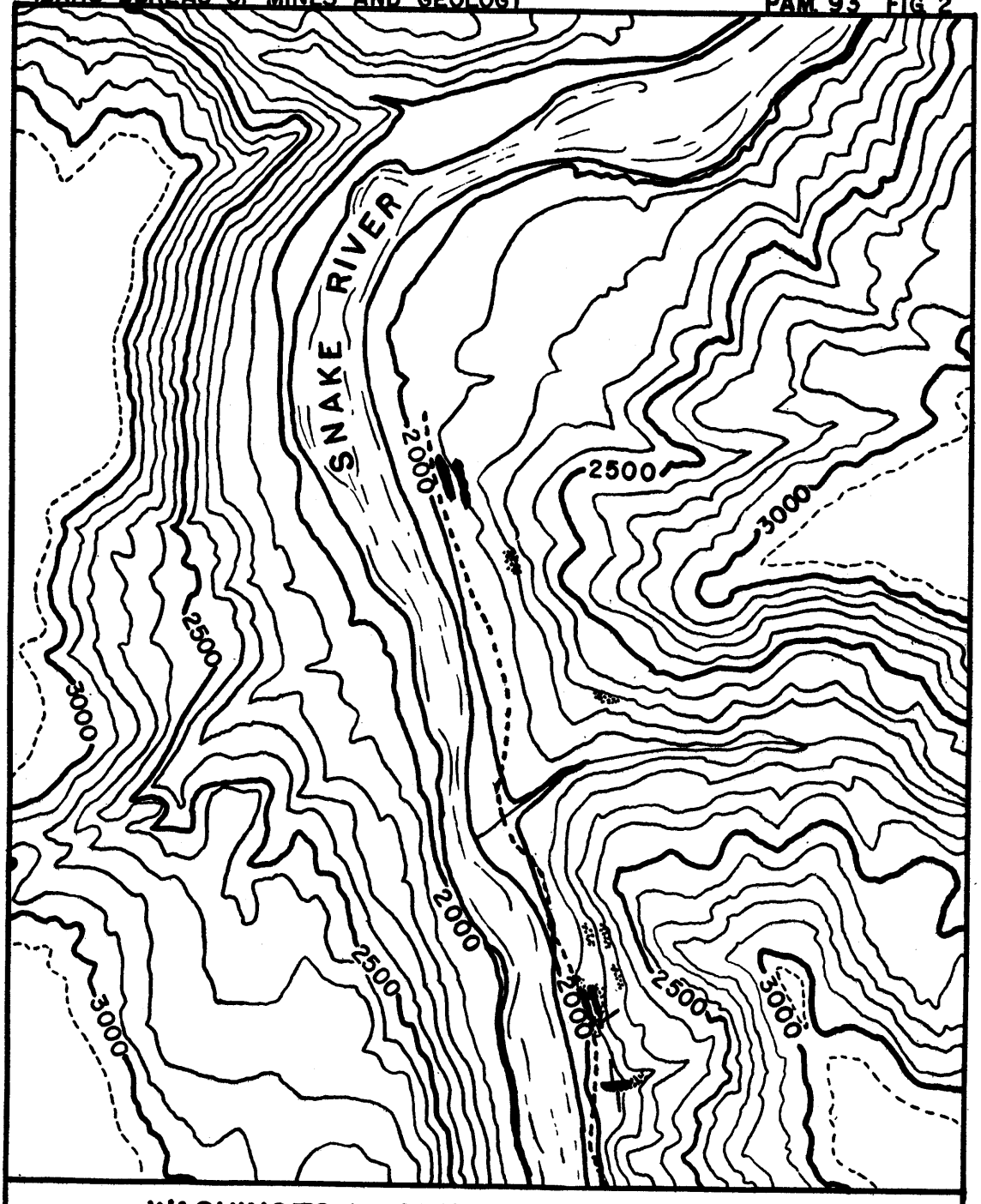
The gypsum showings which are being developed, occur within 1000 feet of the river and at less than 200 feet above the river level. Some stripping and trenching has been done on the higher levels, but where gypsiferous rock is exposed, it is not of high quality.

The topography in the immediate vicinity of the deposits is not sufficiently rugged to hinder development. In some cases, gypsum could be quarried directly out of the face of the hill, thus turning the slope of the land into an asset. There is enough flat or gently sloping land between the river and the deposits to allow for the building of whatever plant and storage facilities might be required in the development. Some indication of the topography may be had by referring to Fig. 2.

DESCRIPTION OF THE DEPOSITS

Gypsum is a hydrous sulphate of calcium with the formula $CaSO_4.2H_2O$. In the pure state it contains 46.6 per cent sulphur trioxide (SO_3), 32.5 per cent lime (CaO), and 20.9 per cent water. The sulphur content thus would run about 18.6 per cent. Anhydrite is calcium sulphate ($CaSO_4$) without water in its formula and it lacks the special qualities which give gypsum value.

Deposits of gypsum usually occur interbedded with sedimentary formations. Such deposits are thought to have been formed by the evaporation of sea water in marginal basins. This theory could account for the formation of thin beds of gypsum, but it is difficult to envisage the conditions under which evaporation could lead to the laying down of beds of gypsum and anhydrite over 300 feet thick, which are known to occur. There are modifications of the marginal basin



WASHINGTON COUNTY GYPSUM DEPOSITS

0 2000 4000 FEET

CONTOUR INTERVAL 100 FEET

EXPOSED GYPSUM STRIPPED AREA TUNNEL

BASE - CORPS OF ENGINEERS SN-148-V9

theory which attempt to account for such thicknesses, but the geologic origin of gypsum deposits is still not a clear picture.

It is recognized that some gypsum may form by the action of sulphur on lime-rich rock. Sulphuric acid, yielded by the decomposition of sulphide minerals, or sulphurous gases of volcanic origin, may react with limestone to form calcium sulphate, or in the presence of water, gypsum. This method of origin has not been advocated for any of the major gypsum deposits, but is of interest in the case under discussion.

In general, the Washington County deposits appear to occur as banded lenses of varying thickness with observed lenses as much as 30 feet thick. The quality of the gypsum varies both along and across the strike, and in the best exposed faces is purest in the center. The most noticeable impurity is a greenish chloritic material which is flecked along the banding in many places.

Gypsum of varying purity has been exposed in a number of localities by stripping. In some of these locations, the banding in the rock varies so considerably over short distances that no accurate strike can be taken. In other locations, the banding is quite regular. Areas of contorted rock may grade laterally into areas of regular banding. Where it was possible to take a strike and dip on the gypsum, the readings were found to agree with one another sufficiently well to indicate that the various locations, although probably not physically connected, are structurally related. Strikes vary from N. to N. 55° W. The variation away from N. increases as one moves from south to north over the deposit. Dips are all to the east, and vary from close to vertical at the southernmost cutting, to 30° near the north end. Few outcrops other than gypsum-bearing rock were seen in the immediate area. These were largely greenstone, and did not reveal structure apart from a general N.W. trend which is indicated on the aerial photos.

Although the deposits appear to occur as lenses, no complete section across a lens is exposed nor is there a complete section along the strike of a lens.

The most comprehensive survey of the general rocks of the area is in the report by Livingston, who measured a good exposure of what are thought to be equivalent gypsum-bearing beds on the Oregon side. His Triassic section was taken at the Bay Horse mine, which is opposite the south end of the Idaho area under consideration. There, Permian volcanics are overlain by 200 feet of Triassic rhyolite. His Triassic section above the rhyolite includes

> "purplish conglomeratic schist, which grades into fine shaly limestone, about 500 feet; greenstone, evidently a fine volcanic tuff, 375 feet; fine gray yellowish and purplish shales containing beds of gypsum, 1000 feet; limestone, 50 feet; purplish conglomeratic schists, about 200 feet. Above this group lies a great thickness of clay slates, at least 20,000 feet____".

The Idaho outcrops which were examined, take in the greenstone, shale, gypsum, limestone part of this sequence. The greenstone, which underlies the gypsum bodies, is a chlorite schist which appears to have resulted in part from the cataclastic metamorphism of a sedimentary-volcanic sequence. The limestone, which in this area characteristically caps the gypsum bodies, and is a rusty brown color, due to the oxidation of contained iron.

A preliminary examination of a series of thin sections of specimens which were taken across one of the gypsum lenses, has given some information on the relationship between the gypsum and the enclosing rock, but there is not sufficient evidence to indicate conclusively the mode of origin of the deposits As with most gypsum deposits, these occur in a sedimentary sequence, but the changes which have taken place since the deposition of the sequence preclude considering them as true sediments now. This is of some importance in the development, since it rules out the possibility of estimating the extent of the gypsum bodies by considering them as tabular layers or beds until additional information is obtainable.

The conditions in the area indicate that the possibility of the formation of gypsum by the action of sulphur on limestone should be given serious consideration. There is limestone in the sequence, and there is considerable sulphide mineralization in the area. At the Bay Horse mine, directly across the river from the southernmost gypsum showings, tetrahedrite associated with small quantities of other sulphides, was formerly mined. In the Mineral district, some 8 miles to the northeast, sulphides are again found to be the dominant minerals.

With this possibility in mind, certain of the sections were inspected to check evidence of the replacement of calcite by gypsum. There is evidence of calcite replacing quartz in the greenstone, and of calcite replacing gypsum in one of the purer gypsum sections, but no evidence was seen which would indicate that the gypsum was formed by the replacement of limestone. This negative type of evidence does not rule out this as a possible origin, but it is hoped that further work may reveal information which will permit definite conclusions.

The old workings on the Oregon side of the river which Wagner examined in 1946, are some four miles south of the Idaho deposits and are located high on the side of the valley, about 2000 feet above the river. In the large underground rooms which were still accessible at that time, he found much evidence of faulting, which gave rise to wide variation in the strike and dip of the formation. He gives considerable weight to the possibility of formation by the action of sulphur waters on limestone, rather than by the deposition in restricted sea basins, and presents evidence from the area that such waters were available.

Gypsum occurs again on the top of a high hill near Mineral. This

occurrence is also in Livingston's "Gypsum Formation", which outcrops in that area. Here again limestone is present in an area of sulphide mineralization.

In each case in which a concentration of gypsum has been investigated, there is not conclusive evidence that the deposits are of true sedimentary origin, although they may have been derived from sediments. The conditions postulated for the formation of gypsum by replacement of limestone are present in each case. There can be little doubt that the origin of gypsum is a more complex problem than is generally recognized, and the work which has been done to this point on these deposits has done more to point out the problem than to alleviate it.

There is a belief, prevalent among the men who have done development on the Idaho deposits, that the gypsum on the east side of the river slid down the hills, and was formerly at a higher elevation. This belief may be due to the fact that the gypsum formation on the west side of the river is some 2000 feet above that on the east, and possibly also to the presence of landslides on the Oregon side, which have carried much gypsum down to the river level. This line of reasoning leads to the conclusion that the gypsum now exposed is only that part of the formation which slid, and that the main gypsum bodies will lie high on the hill.

Little evidence was seen to support this belief. The gypsum is not broken up as it would be in a landslide, and there is no evidence that a mass of rock some two miles long containing these deposits slid down without crumbling. In the area the rock is not broken up as it is on the Oregon side where rock slides are known to have occurred. The only gypsum above the main deposits occurs in pits just north of Rock Creek, which are 300 feet above the Snake and about 1500 feet inland. These are the showings most remote from the general line of

occurrences and are not good gypsum. Limited traversing away from the river showed no further evidence of gypsum, and in spite of the general belief in the slide hypothesis, we found no one who could state that there was good gypsum up the slope from the main showings.

EXTENT OF DEPOSITS

The preceding discussion indicates that the deposits are not continuous, so estimates of tonnage must be made for each individual occurrence. This would necessitate a good deal of drilling or stripping before any sort of precise estimate could be reached. The development work which has been completed to date is not sufficient to serve as the basis for this sort of estimate. The stripping does indicate that there is gypsum at several locations, that there is no gypsum at others, and that when present, the gypsum grades in quality both laterally and vertically.

Three tunnels have been driven on the claims, (see Fig. 2). One tunnel runs along the strike of an occurrence for about 100 feet, in impure gypsum all the way. A second tunnel was driven through 93 feet of shaly country rock without encountering gypsum. A third tunnel, now closed by blasting, is reported to have been driven through good gypsum. At the time this tunnel was open, F. W. Handy is said to have placed a figure of something over 300,000 tons on the proven reserves.

This low figure should not be interpreted as indicating that the deposits are small. Rather, it indicates that more work must be done to show their true size. If the properties are to be developed as a large-scale operation, with the consequent major expenditures for plant and transportation facilities, detailed drilling and mapping should be carried out to give a valid figure for the reserves. On the other hand, there is enough gypsum in evidence to

justify the relatively inexpensive facilities needed to produce and transport agricultural gypsum, provided a sufficient market exists locally.

ECONOMIC IMPORTANCE

From the information which has been gathered for this report it is possible to evaluate the gypsum deposits in terms of certain factors which might influence their successful development. These deposits along the Snake River are the chief potential producers of gypsum in the state of Idaho, and it is of value to the state that they be developed if such development is economicall feasible. The following sections deal with the more important economic factors both in a general way, and as they apply to the deposits under consideration.

Uses

Most of the gypsum produced in this country is used in the building industry. This goes mainly to make plaster or plasterboard, for which the gypsum must be calcined, or partly dehydrated to the form widely known as "plaster of paris". This widespread use of calcined gypsum in building is due mainly to its affinity for water, and its ability, when combined with water, to revert to a hard, rock-like state.

Minerals Yearbook statistics indicate that somewhat less than one-quarter of the gypsum produced is used in the uncalcined state. The chief use here is as a retarder in Portland cement. The addition of gypsum to cement serves to slow down its setting time.

The use of gypsum as a fertilizer and soil conditioner is the other main outlet for the uncalcined product. Although agricultural gypsum accounts for less than 5 per cent of the national consumption, it deserves some attention here, as this use may be of particular interest in Idaho.

Agricultural gypsum performs several functions when added to the soil. Among those cited in the literature on the subject are the following:

1. It provides sulphur trioxide, which is an essential food for certain plants.
2. It assists in the decomposition of insoluble potash silicates, rendering the potash more available to plants.
3. It stimulates the growth of nitrogen-fixing bacteria in the soil, thus increasing the supply of available nitrogen.
4. It improves soil texture, breaking down hard, clayey soils, and increasing the coherency of loose friable soils.
5. In irrigation districts, the sodium carbonate of the black alkali soils is said to be converted from the carbonate to the more soluble sulphate, which brings about improvement in soils texture and composition.

The following table adapted from the Minerals Yearbook 1949 shows the chief gypsum products, and the amount of gypsum used for each in 1949:

TABLE I

Principal Gypsum Products Sold or Used in the United States 1949

Calcined uses		
Base-coat plaster	1,824,790	short tons
Prefabricated lath	1,519,776	short tons
Prefabricated wallboard	2,036,548	short tons
Uncalcined uses		
Portland cement retarder	1,528,440	short tons
Agricultural gypsum	425,646	short tons

These five uses accounted for over 85 per cent of the gypsum used in the country; and it can be seen that calcined products accounted for about 65 per cent.

Markets

As the foregoing table clearly shows, the great market for gypsum is in the building industry. Most of the large gypsum operations produce to serve this market.

The market for building material in western Idaho and immediately adjacent areas is probably not great enough to warrant the setting up of the processing plants necessary to make gypsum products. However, the demand in the Pacific Northwest is great and there are few gypsum deposits in the area to satisfy this demand. At present there are gypsum operations in California, Nevada, central Montana, and Wyoming, all of which can supply gypsum products to Idaho, Washington and Oregon. The one plant which has operated in Washington gets its raw gypsum from British Columbia.

If further exploration reveals the Washington County deposits to be of substantial size, their location with respect to this large market area should allow them to produce gypsum products for the Pacific Northwest, or to ship raw gypsum to plants in the area.

The market for uncalcined gypsum for use as a retarder in cement has not been investigated. It should be noted, however, that there is a cement plant at Lime, Oregon (see location map Fig. 2) which is only about 6 air miles from the deposits. It is doubtful that the deposits could be developed solely on the basis of this market, but if the deposits are opened up to serve a more general market demand, this nearby cement plant is a possible customer.

The qualities of gypsum as a soil conditioner make it well adapted for use on some of the sulphur deficient, or alkaline soils of southwest Idaho. The need for agricultural gypsum in the irrigated areas close to this potential source of supply is increasing and creates an obvious market which should ultimately lead to the development of the deposits.

There is a problem here which must be overcome before the deposits can be brought into production to serve the agricultural market. The government encourages farmers to use gypsum fertilizer by giving them a rebate of 2½¢ per pound of contained sulphur on agricultural gypsum which contains 17-19 per cent sulphur. The present interpretation indicates that there is no rebate if the gypsum falls below 17 per cent.

Tests which have been run on the gypsum from Washington County indicate that it runs slightly under 17 per cent. A test by L. S. Prater of the Idaho Bureau of Mines and Geology, made in 1947, showed a sulphur content of 16.4 per cent, compared with the theoretical 18.6 per cent in pure gypsum. Since the impurities which bring the grade of this gypsum below the required limits, do not appear to affect its use as a fertilizer, it would be a great help to the local farmers if the minimum sulphur requirement could be lowered so that they could take advantage of these deposits.

The only treatment necessary for agricultural gypsum is that it be crushed to 1/16 inch or finer so that it can be spread through farm machinery. Normall it is sold in 100-pound bags for ease of distribution and handling.

Prices

Raw gypsum has a low value per unit weight. The following figures, again from the Minerals Yearbook 1949, show the average value per ton of the products which accounted for most of the gypsum used in 1949 as shown in Table I.

TABLE 2

Average Value of Principal Gypsum Products
1949

Calcined uses	
Base-coat plaster	$11.70 per ton
Prefabricated lath	21.36 per ton
Wallboard	28.03 per ton
Uncalcined uses	
Portland cement retarder	3.27 per ton
Agricultural gypsum	4.20 per ton

It is to be expected that these values have increased since 1949 but that they are still of somewhat the same order.

The selling price for agricultural gypsum in the Weiser area during the summer of 1951 was $16.00 per short ton. This product was shipped in from Nevada. The price in Moscow, for a similar product from Heath, Montana, was $18.00 per short ton in January, 1952. These figures indicate that a large part of the price to farmers is due to costs of processing and distributing. The government rebate, which would amount to $7.50 a ton for 17 per cent gypsum would return a substantial part of the price to the farmer.

Other Factors

One of the most important factors in the development of any mineral resource is accessibility. This has been dealt with in the main body of the report, so a brief review will serve here. The deposits are 18 miles by road (7 air miles) from a main line of the Union Pacific Railroad, or about one-half mile from the Robinette branch of the Union Pacific, which runs along the other side of the river. They are 30 miles from Weiser, by a road which would require improvement before it could be used for heavy traffic.

Methods which have been considered for getting the gypsum to market include trucking it to Weiser; trucking it to a rail siding which would be built where the Union Pacific crosses the Snake River; and building an aerial tramway to carry it to the railroad on the Oregon side of the river. The most economical method would be determined by the scale of operation.

Adquate power is available to run any operation which is contemplated. A transmission line of the Idaho Power Company runs along the Oregon side of the river.

Fresh water is available in the Snake River, to fill any demand which

may be made of it.

The labor force in the area was not investigated, but the area is not sufficiently isolated that this should be any problem.

As is indicated on the topographic map (Fig. 2) there is level land near the river and above the high level of the river on which to set up any buildings or storage facilities which might be needed. This would be of value if a manufacturing plant is contemplated. It has been found that it is more economical to locate manufacturing plants which use gypsum as a raw material near the deposits than to transport the low-value raw gypsum to a processing plant near markets.

CONCLUSIONS

At the present stage these deposits show enough gypsum to warrant development to serve the important local agricultural market, if it can be arranged for the farmers to receive the government subsidy.

There is the possibility that the deposits could support a large-scale operation geared to supplying the market for gypsum products in the Northwest. Extensive diamond drilling should be done before any such large-scale operations are considered, in order to learn whether the gypsum supply is adequate. It is likely that such drilling would turn up more good gypsum, but on the basis of the work which has been done to this point, the amount is not predictable.