ECONOMIC EVALUATION OF PHOSPHATE AND
OTHER MINERALS IN SOUTHERN
IDAHO

By

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(Edited by J. D. Forrester)

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FOREWORD

For many years Idaho's mineral production consisted almost entirely of metals and that fact was reflected in the publications of the Bureau of Mines and Geology. Because metals have high value per unit weight and their ores can be processed into a uniform product selling at a uniform price, such factors as transportation cost and nearness to market are not as important in metallic mining as they are in the nonmetallics field, where the product generally has low value per unit weight and may be variable in quality. Consequently Bureau publications have given comparatively little attention to economic factors.

Today the mineral picture is changing rapidly. Idaho's nonmetallic mineral production is increasing, lower grade metallic deposits are being exploited, and as a result economic factors are being given greater consideration in mineral exploration than ever before. For this reason we believe the publication of Dr. McDivitt's economic evaluation of some mineral resources in southern Idaho is timely.

Dr. McDivitt's field work, sponsored by the Idaho Bureau of Mines and Geology, resulted in a Ph.D. thesis submitted to the University of Illinois in 1954. That thesis as edited by J. D. Forrester, former director of the Bureau, is here presented as Pamphlet 111. The complete thesis is available for consultation in the Bureau library.

E. F. Cook, Acting Director
Idaho Bureau of Mines and Geology
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INTRODUCTION

No general method exists of appraising the cost of economic factors which influence mineral development. Some of the factors such as modern methods of exploration have received attention but others which may be of equal importance have not. There can be no formula into which the details of a deposit are fitted and its exploitability determined. However, an evaluation of the various factors which should be considered in the development of mineral deposits is of value in lieu of a formula.

Such an evaluation is presented here as a guide in working out the exploitability of mineral deposits, with particular reference to the mineral deposits in southern Idaho. Several mineral deposits are evaluated in terms of the criteria set up, and the effect of the various factors on mineral development within the state is considered.

The relative importance of each factor varies from mine to mine and from area to area. Furthermore, in time the approach to this whole field of deposit evaluation in terms of economic factors will change, and the interpretation given here must grow and be improved upon as we gain more understanding of the problems.

The mineral wealth which served us during past years is still with us, not always in the large, easily recoverable deposits of the past, but in such quantities that the country need have little fear of becoming a "have-not" nation. We know that deposits on which we have relied are being and ultimately will be exhausted. We see an increasing use of ore from other countries. We see an increasing use of ore from many small deposits rather than a few large ones. We see a need for a new approach toward mineral resources necessitated by our increasing maturity as a nation, and we are moving toward this new approach.

The progress we have made, and some of the steps yet to be taken are evaluated in the 1952 "Paley Report" (President’s Materials Policy Commission, Vol. 1, p. 26). Among its conclusions are the following:

There is no comprehensive program, government or private, for collecting and analyzing the facts on reserves, costs and rates of exploration and development and other facts pertinent to showing the situation in reasonable detail and outlining the prospects for different minerals. The Commission’s inquiries revealed at first hand that national estimates of reserves proved particularly meager and hard to come by.

The view expressed here indicates a need for an evaluation technique which considers the various cost factors in mineral development in their total effect rather than in isolation. While it is probable that mining companies, particularly those with wide interests, have developed such a technique for their own use, no detailed method of analysis has been given general circulation. However, enough general knowledge is available to permit the undertaking of such an evaluation.

The author attempted to arrive at evaluations of economic factors affecting several southern Idaho minerals through a program of study and appraisal combined with field studies over a period of two years in 1952-53.
The resulting paper was submitted in partial fulfillment of the requirements for the degree of doctor of philosophy in geology at the University of Illinois in 1954. The author thanks George W. White of the University of Illinois and Walter H. Voseull of the Illinois State Geological Survey for guidance and criticism; the Idaho Bureau of Mines and Geology for making available funds and facilities for the survey; Harry H. Caldwell and Milton A. Voigt of the University of Idaho for assistance; and his wife, Louisa, for her encouragement.
ECONOMIC FACTORS INFLUENCING MINERAL DEVELOPMENT

Mineral resources are set apart from other types of natural resources because their location is fixed by nature, and because they are exhaustible -- when a deposit has been used up, it cannot be renewed. Although we are using up valuable mineral deposits, most people who have worked in the mineral industries do not take an alarmist view. Recent developments in southern Idaho, an area which has been thoroughly prospected by conventional methods, illustrate that the mineral industry has far more flexibility than is evident when one considers only the factors of fixed location and exhaustibility. Although the deposits are fixed and exhaustible, the conditions which make them exploitable are not fixed, and these conditions vary widely within limits set up by the need for each mineral.

Since the basic factor which determines whether or not a particular mineral deposit will be developed is the cost which the user must pay for the mineral at the place of use, economic factors which should be considered are those which will affect this cost. The relative importance of these factors varies. The factors that apply in southern Idaho would not be weighted the same in other areas.

Geology as an economic factor

There are three main stages at which geology affects the cost of mining development:

1. Regional geology as it affects regional development.
2. Exploration and discovery.
3. Development and mining.

Regional geology

The geologic history of an area determines the topography of the area, and also determines the location and degree of concentration of minerals within the area. Unfortunately from the economic point of view, the geologic history that leads to ore deposits close to the surface is the history most likely to result in extreme relief. Most of the rich ore deposits of the world are found in rugged or mountainous country, and these areas also are the least adaptable to other types of economic activity. The economy which develops in them usually must be based on natural resources.

Geology throws an immediate burden on the isolated ore deposit, for unless it is rich enough to support a complete mining community it must be developed on a small scale by men willing to work and live in some isolation. Where there is another source of income in the community, the mineral deposit does not have to bear all the costs of transportation, utilities, and other services, and thus less rich deposits can be developed at a profit.

When bad climate is added to problems of terrain, the day of exploitation is pushed further into the future.
The part of central Idaho bordering the Idaho batholith provides many examples of mineral deposits which are not economic because of the terrain. The drainage pattern of the batholith is haphazard, and there are no direct natural routes for transportation lines to follow. In most parts of this interior region, a deposit would have to be phenomenally rich to justify the great investment needed to provide good access.

Exploration and discovery

Geology as a science is playing an increasingly important part in keeping down the cost of prospecting. It is highly likely that most outcropping ore deposits have been discovered. The old-time prospector is being replaced by men trained in the use of equipment and techniques which give a knowledge of the rocks below the surface. Discovery of new deposits may hinge on the geological survey of a very broad area in an attempt to discover significant trends, or on geophysical work that requires expensive equipment. The expense of prospecting and the risk of discovery must more and more be borne by large organizations, often by mining companies which will work the deposits they discover. This paints a discouraging picture for the small operator, but it is made brighter by the work of the federal and state governments in making surveys to increase general knowledge. Government work is particularly valuable in new areas where the cost is too great and the probable return too nebulous to interest industry.

Samuel Laskey (1947) suggests a philosophy for mining geologists which bears many resemblances to that of the petroleum exploration geologists. Laskey feels that geologists must attempt to interpret evidence without regard to their prejudices, bearing in mind several possible theories of ore control, rather than the one they favor. Adoption of this philosophy would require in effect that mining companies sink "wildcat holes" like the oil companies, to test the evidence.

Development and mining

The part played by geology within an ore deposit has been recognized, but the part that the geologist can play in the development of an ore body has often been neglected. When mineral reserves were plentiful, and mining costs were low, the mining engineers' knowledge of geology was sufficient to work out problems that arose, but now when planning and development within the mine is more expensive, it becomes necessary to employ a geologist with theoretical as well as practical knowledge to make better use of the money spent on mine development.

Transportation as an economic factor

Supplies and equipment must be moved to mines and the mineral products must be taken away to processing plants and to the market. The cost must be borne by the mineral deposit. In most industries location can be changed to reduce high transportation costs, but this is not true with minerals which have fixed location.

Transportation facilities and requirements

Where all facilities are available, cost of long-distance moving is least by barge or boat, higher by rail, and highest by truck. Where the haul is less than 60 miles, truck and rail costs are about the same. (U. S. Senate Doc. No. 84, 1944, p. 9).
Water transportation is not important in Idaho but may be used by deposits competing with Idaho producers. Rails carry the bulk of Idaho mineral movement, with trucks used for short hauls, as from mines to processing plants, and for developing deposits in remote areas.

**Accessibility**

If a mineral deposit has access to existing rail lines, the operators may move their products by rail at regular rates over lines constructed for other purposes. Many of the patented phosphate claims in southeastern Idaho are well located with respect to the Union Pacific Railroad and thus have a significant cost advantage over the more remote deposits. Since this is the most ideal situation short of location at the market, areas adjacent to rail lines have been quite thoroughly prospected.

If the deposit is in an area where rail facilities can be built without great cost, the size of the deposit determines whether a line can be built. The entire cost of the line must be assessed against the deposit. The cost of spur construction is high, ranging from $60,000 per mile in rolling country to more than $300,000 per mile in mountains. The spur to the Conda mine was constructed in 1920 when costs were lower than today and trucking was not so well developed. A different transportation system might be chosen for such a situation today. Technological advances in vehicles and road construction have made road transportation cheaper and more reliable than it has been in the past, and have made possible the development of many mining areas.

If transportation is available over an existing rail line, scale of operation will be determined by the market with normal transportation costs considered as a part of production costs. The Waterloo phosphate mine near Montpelier is an example.

If a rail line is built, the scale of operation must be large enough to amortize the line and facilities. Phosphate mines at Conda and Fort Hall are of this type.

If trucks are used, the system is flexible. Small operators may bulldoze a road, mine on a small scale in the summer, and truck a few loads a year to the railroad. Even large scale operations may be carried on by truck. Cobalt concentrates are trucked 107 miles to the railroad at Mackay, and some 300,000 tons of phosphate annually are trucked 18 miles to the processing plant of the Monsanto Chemical Company.

**Transportation costs and their effects**

Rail rates are negotiated by the shipper and the carrier on the basis of the following factors: competition of private carriers, rates of competing for-hire carriers, value of the article, what the traffic will bear, risk in handling, bulk or weight, cost of rendering the service, and cost to the shipper. (U. S. Senate Doc. No. 84, 1944, p. 16). There is a great deal of variation in rates. Southern Idaho producers have access to only one rail line, but the rates are influenced by the fact that phosphate deposits in nearby states are served by competing lines, and freight rates in Idaho must be low enough to permit competitive production.
Mineral products have a wide range of value and hence of ability to bear transportation costs. A ton of cobalt concentrate has a much greater value than a ton of phosphate rock, and it can therefore be transported farther or across more difficult terrain. Railroad rate making policy offsets this advantage somewhat, but there is no consistent relation between freight rates and value.

Transportation costs help decide plant locations. Usually treatment of low value ores results in a considerable decrease in weight, so a plant is located as near as possible to the mine. In the phosphate industry it is less expensive to ship rock to plants in Utah than to ship sulphuric acid to Idaho. In making elemental phosphorus it is cheaper to move electric power to the plant near the deposit than to move phosphate rock to the generator. Final processing plants are usually located near the market and thus Idaho's elemental phosphorus is shipped to outside market areas to be converted into consumer goods.

Transportation facilities in Idaho

The two main rail lines across southern Idaho were built to follow trail routes. The Utah Northern Railway from Utah to Butte was completed in 1881 and by 1890 had been converted to standard gauge and consolidated with the Oregon Short Line. The Short Line from Granger, Wyoming, west across Idaho was completed in 1884. The land it traversed was not good for settlement, and the line was built to bridge the region rather than to serve it. The mines of the Wood River District were then in production, and a branch line was run north from Shoshone into the Wood River Valley to tap this resource before the main line was completed. Another early branch was built up the valley of the Little Lost River to Mackay, and another from Idaho Falls to West Yellowstone, Montana. Branches south of the main line serve the rich farming areas between Burley and Twin Falls, and one route makes connection with the Southern Pacific and Western Pacific at Wells, Nevada. All the rail lines in the area are a part of the Union Pacific system.

A network of highways reaches into many parts of the state which are not served by railways, opening the way to at least limited mineral production in these areas. The cost of joining deposits to existing roads must often be borne by the mineral deposits, but in many cases aid can be obtained from the state or county. Forest Service roads in most of the mineral districts are adequate for small-scale operation, but heavier traffic would require improvement, possibly with the aid of the government. Many of the roads are not maintained in the winter, but operators can stockpile while the roads are closed to heavy traffic.

The opinion is often expressed that the absence of extensive mineral development in the remote parts of the state is due entirely to the lack of transportation facilities. This reasoning is partly valid. Good roads built by the state would enable new deposits to operate at a profit. However, if large deposits on the order of those in the Coeur d'Alene district existed in the area, no lack of government aid would long hinder their development.
The Market as an economic factor

Certain characteristics distinguish the market for mineral products from that of most other types of product. Minerals, particularly metals, have a high degree of uniformity which allows any operating deposit to meet the quality demand of any market. This leads to a uniform price. Since deposits and markets do not coincide, there may be great variation in the cost of moving minerals which would favor the deposit closest to the market. The uniform price makes profit variable as the costs of different mines vary and sets a limit on allowable production costs. The uniform product also makes it difficult to try to stimulate sales of a particular mine through advertising, and stimulating the general demand for a mineral is equally difficult because the demand is not direct but tied to the demand for goods using minerals as raw materials. Thus normal competition for the market must be on the basis of service rather than quality and distinctive features.

This is less true of the nonmetallics than of the metallic minerals. Garnet may or may not be satisfactory for use as an abrasive, or mica may be pure but have no economic value due to physical imperfections. However, nonmetallics are restricted in their market by low value per unit weight and by relative abundance of the deposit.

Factors influencing mineral markets

Most minerals are limited in occurrence and deposits have little geographic reference to the market. A single deposit must market at the going price or not produce. When lack of demand lowers price, mines must either close or operate at a loss in hope of rising prices. Single-mineral mines are at the mercy of changing prices and markets. If a large market is developed for a mineral with high production costs, the large scale of operation may make possible the lowering of such costs, so that the deposit may be operated.

Freight rates, as noted, are an important factor in total production costs. The producer can map the area in which he may market when he knows his transportation costs. Since the principal competitors of Idaho phosphate are Tennessee and Florida, there is a large natural market for each producer and the area of conflict is more than a thousand miles from the deposits. Different production costs complicate the sharp line that freight rates would draw between the competitors in this industry.

TABLE 1 — Transportation rates for one ton of superphosphate fertilizer to Omaha, Nebraska*

<table>
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<tr>
<th>Freight Rate increments</th>
<th>From Montpellier, Idaho</th>
<th>From Tampa, Florida</th>
<th>Differential in favor of Montpellier</th>
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<tr>
<td>Base Rate, June 1946</td>
<td>$ 7.40</td>
<td>$14.00</td>
<td>$6.60</td>
</tr>
<tr>
<td>Ex Parte 152 (20% $12.20 max.)</td>
<td>8.60</td>
<td>15.20</td>
<td>6.60</td>
</tr>
<tr>
<td>Ex Parte 156 (20%)</td>
<td>10.32</td>
<td>18.24</td>
<td>7.92</td>
</tr>
<tr>
<td>Ex Parte 168 (6%)</td>
<td>11.15</td>
<td>19.70</td>
<td>8.55</td>
</tr>
<tr>
<td>Ex Parte 175 (15%-60% max.)</td>
<td>11.78</td>
<td>20.30</td>
<td>8.55</td>
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*Source: Bell and Griffith, "Transportation Costs as they Affect New Phosphorous Industries in the West," (Bonneville Power Administration, June, 1947), p. 5. ( Mimeographed). Revised to 1953.
Production costs are lower in Florida than in Idaho. If due to lower production costs Tampa could in 1936 supply superphosphate to Omaha for the same price as operators at Montpelier, the increases in freight rates may well have ruled out such a market today. Rising freight rates may cause a continual shift in the market area which can be served.

In Idaho much of the phosphate production is from "captive mines," which market rock to the parent company, thus restricting the market available to other producers. Even some independents contract to supply a particular market and might be considered "semi-captive."

Government stockpile and purchase for defense uses provides a significant market for some minerals, and government aid lowers production costs on others so that they may operate competitively.

Foreign deposits, often with local or United States subsidy, can in some cases supply the U. S. market more cheaply than the domestic deposits. Tariffs have been used to equalize lower foreign costs on some minerals.

Substitutes are constantly changing the mineral marketing picture. Aluminum has taken over many of the markets formerly held by copper. Plastics have opened up new markets for some minerals and created substitutes for others.

Market research has played an important part in developing new uses which have made possible large-scale production and lower prices. Idaho phosphate deposits were developed largely to serve the new market created by detergent cleansers, and the search is still on for more new uses. Normally this research is done by large producers and developers, but cooperation of small producers, government bureaus and universities is important in continued expansion.

The market for Idaho minerals

The small population of Idaho and Utah does not provide a large enough demand for finished products to warrant setting up large scale industrial plants within the area. Much phosphate fertilizer is used locally, but most of the phosphorus recovered is marketed outside of Idaho, and the same is true for most of the rest of the state's mineral production. Since the minerals must compete for national markets with deposits from other states, many of the low-value minerals must remain undeveloped or undergo limited development.

Power as an economic factor

The use of power in the development of vast low-cost mineral ventures has aided in giving the nation a broad mineral base upon which to build its industrial position. Mainly this has been electric power, generated by water-driven turbines, coal-fueled steam plants, or petroleum-fueled diesel generators, and each of these methods has been of significance to the minerals industry. Diesel power has helped in the early stages of mine development, to be replaced later by hydro or steam-generated power.
Since power is almost always available and makes up a relatively small part of the cost of mining operations, it would normally be a minor economic factor. However, in Idaho and the Pacific Northwest power is important and must be considered in some detail due to the large number of electro-metallurgical plants in the area.

Water Power

The Pacific Northwest states contain less than 4 per cent of the population of the country but 37 per cent of the potential hydro-electric power and 24 per cent of the developed capacity. Ninety per cent of the region's power is hydro-electric as opposed to less than 5 per cent for the country as a whole. (Higginson, 1950, p. 79). Low-cost electric power has permitted building up of industries which are heavy consumers of electricity, such as aluminum which uses 9k.w. of electric power for each pound of metal produced. Electric furnaces for production of phosphoric acid are also heavy consumers.

Heavy users have so increased demand for power that present capacity is not enough to supply the year-round demand, particularly in years of low run-off. Power from new plants cannot be sold as cheaply as that from existing generators, because building costs have risen and the best sites have been taken. All of southern Idaho's power at present is hydro-electric, although some steam power is imported from Utah in periods of high load or low water. Cheap hydro-electric power is a decided asset to the area, as it makes possible heavy power-consuming industries such as the phosphate furnaces.

Although coal now plays a very small part in the development of Idaho, its future role cannot be overlooked. The time may come when it will be more economical to generate power from coal than from hydro-electric plants. Teton County has coal of good quality, sub-bituminous to high-grade bituminous, low in ash, sulfur, and moisture.

Diesel power is of particular value in the early stages of mining, as generators can be moved into an area to provide power for exploration, drills, compressors, and power tools. Wildcat well drilling rigs generate their own electric power using diesel.

There are plans to pipe natural gas into the state, where it might be used as a fuel in mineral processing. No oil or gas is produced in Idaho at present.

Government policy as an economic factor

Government agencies help the mineral industry through exploration, mapping, road construction, regulation of claim holdings, administering mine safety, etc. On the other hand, the government taxes production, controls mineral entry, and in other ways restricts mine operation. Policy may affect the mineral industry adversely while acting in the best interests of the country.
Federal Policy

The government owns some 64 per cent of the land in Idaho. Most of this is open to prospectors and can be developed in the normal way. It also controls mineral entry on the phosphate reserve in southeastern Idaho and adjoining states, much of which is privately owned. It is responsible for roads on government property, which pays no taxes to local political units. Mine operators in the federally-owned areas of Idaho must build access roads to their properties from the nearest forest roads, which in Wilderness Areas may be at some distance. The Forest Service cannot hinder mining operations in the National forests, but it does not have funds to aid mining by building roads to specific properties. The roads built to the cobalt mines were provided by a special appropriation.

The system of filing mineral claims has been criticized by those who contend that claims have been staked to obtain timber and recreational sites. Mining interests fear that any change in the present system would lead to a higher degree of government control. The key question is whether changes are needed to promote mineral development. Prospecting conditions have changed radically from those under which present laws were written, and a company today cannot economically undertake the necessary speculative prospecting unless it has the mineral rights over a broad area. Such rights are not available at present except in the case of minerals covered under the Oil Land Leasing Act of 1920. The phosphate leasing program in Idaho and adjoining states follows the general pattern of allowing the leasing of large blocks of land under terms which encourage development. In the case of other minerals the present mining laws tend to restrict the use of modern exploration techniques on public lands. The breaking up of an area into many small claims leads to a great waste in exploration, high development costs, and inefficient mining.

Several government agencies aid in mineral development. The United States Geological Survey classifies mineral or public lands and does topographic and geologic mapping. It has been a leader in development of new prospecting tools such as aerial photography and geochemical prospecting. The United States Bureau of Mines gathers and interprets data on domestic and foreign activity, enforces mine safety law, and carries on research. The Defense Minerals Exploration Administration has funds to aid in development of strategic minerals, and the Defense Materials Procurement Agency helps increase production through purchase contracts and loans. The Atomic Energy Commission gives information and assistance in the search for radioactive elements, and the Bureau of Land Management controls leasing of the phosphate reserves.

Mining companies pay corporate income tax and excess profits taxes which, in 1953, could take up to 22 per cent of taxable income. The taxpayer may take a percentage depletion allowance on metals and on some nonmetallic minerals, including fluor spar, garnet, mica, and phosphate rock. The allowance varies from 5 to 27 1/2 per cent of gross income. For all metals and for the mentioned nonmetals the allowance is 15 per cent. Exploration costs are now deductible to a limit of $75,000 a year per taxpayer for four years. Costs beyond this must be capitalized and recovered through depletion allowances. Development costs may be deducted with no limit.
Money from DMEA is tax exempt, and mines producing strategic materials do not pay an excess profits tax on accelerated production. The Defense Production Administration can allow accelerated tax amortization on investment which is considered necessary for defense. It promotes building of new plants and facilities and benefits most those companies which are paying income and excess profits taxes at or close to the maximum rate.

In taxation there is a point of maximum return both to the mining industry and to the government: a depletion allowance which encourages investment in mining to the point that government revenue is greater than if no such allowance were made. This point cannot be calculated, as it is constantly changing, but continuing attempts must be made to approach it.

State policy

In Idaho where a large part of the land is federally-owned, state policy is less important than federal. The State Inspector of Mines checks safety, collects statistics, and enforces state dredging regulations.* The Idaho Bureau of Mines and Geology carries on research and publishes reports on areas of possible mineral development.

Mining is subject to the state income tax, to the assessment on physical plant and equipment, and to the mine license tax of 3 per cent on gross income less mining expenses. State taxes based on income are not as high as the federal, but on the other hand state deductions are less liberal.

Local policy

The county tax is on production through profits rather than on ore resources as property; it taxes mine profits at the same rate as the property tax, which is most counties is about 3 per cent of assessed value, but the net profits figure is assessed at 100 per cent of value rather than the 40 per cent used for property and equipment.

Taxation on any level is an additional cost which may raise production expense to the point at which mining becomes unprofitable.

Other factors

Climate

Climatic extremes of any sort make development difficult. Once the operation has progressed beyond the development stage it may be possible to minimize many of these effects, but only at a cost to the property which competitors in a more moderate climate do not have to bear. Although the southern Idaho climate is not severe, when coupled with the rugged topography of the interior, it is enough to slow down mining during the winter. The winter weather stops open-pit mining, which becomes much more expensive when the operators must contend with snow and freezing weather. Winter production in inaccessible areas is stockpiled. Summers are moderate, and the climate is excellent for mining work. The prospecting season is even more limited than the mining season. Claim holders who leave their assessment work until spring often have difficulty getting such work under way by the July 1 deadline.

* Recent legislation transfers the administration of the dredge mining regulations to the State Land Board.
Water supply

The mining industry uses large amounts of water for cooling, washing, steam generation, leaching, and processing. In Idaho much of the surface water that might be used in plants is the property of irrigation users, and if ground water is to be used, the site of a plant should be carefully considered. Idaho does not enforce laws on dumping of industrial wastes into streams but doubtless will do so as industrialization increases. A 1953 law requires that dredging operations be equipped with settling ponds. In contrast to the scarcity of water in some areas, abundance of water makes mineral recovery difficult in some underground mines which cut through water-bearing strata.

Labor

Mining does not offer the security that some fields do, but the outdoor life, the adventure, the good wages, and the efforts of mining companies to build attractive communities do offer compensations. Small isolated mines must supply their employees with some community facilities, and this is an expense to be added to the cost of production. Table 2 from information in the 1950 census shows the number of men who make their living at mining in some of the more important mining counties in Idaho.

<table>
<thead>
<tr>
<th>County</th>
<th>Total Employed</th>
<th>Employed in Mining</th>
<th>% in Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blaine</td>
<td>2185</td>
<td>147</td>
<td>6.7</td>
</tr>
<tr>
<td>Caribou</td>
<td>1884</td>
<td>113</td>
<td>6.0</td>
</tr>
<tr>
<td>Custer</td>
<td>1215</td>
<td>108</td>
<td>8.9</td>
</tr>
<tr>
<td>Lemhi</td>
<td>2234</td>
<td>226</td>
<td>10.1</td>
</tr>
<tr>
<td>Shoshone</td>
<td>8762</td>
<td>3656</td>
<td>44.3</td>
</tr>
<tr>
<td>Valley</td>
<td>1492</td>
<td>177</td>
<td>11.8</td>
</tr>
</tbody>
</table>

Competition and substitutes

Mine managers must always face the risk of the discovery of new and better located deposits, the development of a substitute product, and new competition from abroad, any one of which can put them out of business. To combat these dangers, mining competitors have begun to cooperate in advertising, in research, in the pooling of information, and in cooperative exploration.

Conservation

Strict conservation can never be applied to the mining industry, where each operator must decide for himself what his policy is, but most wise mine operators practice conservation because it is to their best interests. Minerals are re-used as scrap material, ore which is left unmined as pillars or marginal ore can be recovered, and technical developments cut down on waste. New substitutes also act to conserve waning supplies of some minerals.

By-products and co-products

There are many examples in the mineral industry of co-production of several minerals from one ore body, a practice which reduces costs. The
lead-silver-zinc ores of north Idaho are an example. Recovery of sulfur from the sulfide ores has created a marketable product from the sulfur gases which once were wasted. Fluorine, vanadium, and uranium are potential by-products of the phosphate industry in southern Idaho. Marketing of various grades of an ore for various uses is also practiced in the phosphate industry. In some areas it is possible to market slag material as road metal, railroad ballast, insulating material or as pozzolan for cement.

Financing

There are four ways in which the money needed for setting up a mining venture can be obtained (Bailey, Raymond and Boerlcke, 1953):

1. Financing by individuals who discovered the property. This is rare because of the large sums necessary today.

2. Development by mining companies which are expanding their operations or by companies which set up "captive mines" to acquire needed materials. This method financed most development in Idaho since World War II.

3. Development by new capital by sale of stock.

4. Development underwritten by the government.

Government aid is available only for the critical materials, through the Defense Minerals Procurement Agency. Speculative capital is less available than in the days of bonanza returns, and most development is therefore done by the existing large companies as they expand their operations.

General remarks

An evaluation of the factors here discussed should indicate whether or not a mineral property can be developed. Since there is no definite formula, many evaluations will fail to yield definite answers, and the answers are further subject to revision as new products and new deposits are discovered. However, evaluation can point to chances of success. Where the combined costs preclude a paying deposit, further expenditures on such a property would appear to be pointless. Thousands of dollars are spent in Idaho each year on deposits which cannot hope to become profitable.

If mining is to be undertaken on a marginal basis, a consideration of all factors might indicate where savings can be made. Development may be warranted on a small scale when, by keeping investment at a minimum it is possible to make a profit. On the other hand, where the margin of profit is low it may be necessary to operate on a large scale to cover overhead.

Complete evaluation should point to the most efficient scale of operation, best plant location, and most economical transportation method.
PHOSPHATE IN SOUTHERN IDAHO

Introduction

In southern Idaho there are many hundreds of known mineral showings, some dormant; some under active development, and some producing ore. Most of the active metal mines are north of the Snake River, whereas the phosphate developments are south and east of the Snake. In choosing properties for case studies in the evaluation of economic factors affecting production, an attempt has been made to give a full treatment to the phosphate industry and its interrelation with other industries of the area. Other minerals have been chosen to show how each economic factor plays its part.

In covering these points it should be possible to present a picture of the overall development in southern Idaho, along with an indication of the future of the area as a mineral producer. Also, by noting which factors provide the main obstacles to more widespread development, it may be possible to plan to minimize the problems created and thus improve the chances of successful development.

Development during the 20th century

Gold was the earliest important mineral in Idaho, first in the rich placer deposits of Idaho and Boise Counties in 1860-70, later in the gold-silver lodes of Owyhee County in 1890-1900. Since 1900 gold has dwindled in importance. The lead-silver districts of Blaine, Custer, and Lemhi Counties reached their peak in the 1880's, and by 1900 production was still being carried on but was not impressive. Metal production in southern Idaho during most of this century represents operation of old mines, many of which are marginal and are worked only when metal prices are high. By far the greatest part of Idaho's mineral production in this century has come from the Coeur d'Alene mining area in northern Idaho, which had more than 92 per cent of the dollar value in 1949.

In southern Idaho the greatest stimulus to mineral development came with the discovery of rich phosphate deposits at the beginning of the century. Many of the better deposits were staked in the first years of the century. In 1908 the government withdrew 4,541,300 acres of land in Idaho, Utah, and Wyoming from all kinds of entry pending an examination of their phosphate resources, thus putting an end to further staking. No leases were allowed on the phosphate lands until after the passage of the Mineral Leasing Act of 1920, which set up the procedure for obtaining such leases. However, the claims which had been filed before 1908 were on some of the best exposures, and some mining was carried out on these claims.

The Waterloo Mine of the San Francisco Chemical Company near Montpelier was the first phosphate claim to be patented. It produced as early as 1906 and is still being operated. Early production from several companies went to the west coast mainly.

Classification of the reserve by the Geological Survey began in 1909 and has continued to the present time. The early phases under the direction of G. R. Mansfield culminated in Professional Paper 152 of the U. S. Geological Survey: Geography, Geology and Mineral Resources of Part of Southeastern Idaho, (1927). The phosphate lands were classified according to (1) quality of rock, (2) thickness of bed, and (3) depth of bed below surface.
Development of phosphate was almost entirely on patented claims, even after the act of 1920 made possible the leasing of land on the government reserve. Chief of many companies active in this development have been San Francisco Chemical and the Anaconda Copper Mining Company. Anaconda entered the phosphate business in 1920, shipping rock from Conda, eight miles north of Soda Springs, to its plant at Anaconda, Montana. This enterprise was established to make use of the sulfuric acid that was a by-product of the company’s Montana operations. This mine accounted for most of Idaho’s annual production until the developments after World War II. In 1926 Anaconda leased federal lands adjoining their patented workings, and since that time most production has been from this leased land. Anaconda was the only company actively producing from leased land in Idaho prior to 1945.

Since the war development has been rapid. The J. R. Simplot Company obtained leases on several phosphate properties beginning in 1945. They and San Francisco Chemical received large orders for phosphate rock to be shipped to Japan; these orders stimulated large scale strip mining.

Simplot ships high grade phosphate rock to its fertilizer plant at Post Falls and supplies phosphatic shale for the electric furnaces of the Westvaco Chemical Division of the Food Machinery and Chemical Corporation, also at Post Falls. Its production is from a strip mine on the Fort Hall Indian Reservation. Monsanto Chemical Company has set up an electric furnace plant at Soda Springs and since November, 1952, has been processing phosphatic rock and shale from its strip mine some 18 miles north of Soda Springs. Idaho production of phosphate rock and shale has risen from 123,340 tons in 1945 to more than 1,250,000 tons in 1953.

The greatest surge in development of other minerals in southern Idaho has also taken place in the last few years. Idaho has become a producer of barite from a mine near Hailey, of fluor spar from Meyers Cove, of cobalt from the Blackbird district and of pumice from Idaho Falls. None of these operations is marginal or “shoestring.” All are designed to serve more than a local market, and in some cases they serve a national market. This new, active interest in the mineral resources of the area has already added a great deal to the history of mining in the region, history of a very different type of mining from that earlier pursued.

The exploitation of phosphate

After the initial surge in 1946-47 to meet foreign demands, the southern Idaho phosphate industry has stabilized and production is now increasing at a steady rate. By the end of 1953 production from the western states, with Idaho as the chief source area, was expected to be second only to that of Florida. The 1953 production figure, representing a ten-fold increase in eight years, is for a year in which new plants and mines in the area were beginning to achieve optimum efficiency, and new properties were being brought into production. It is an indication of expanding production to come. So that the importance of Idaho production will have proper perspective, Florida production also is included in Table 3.
<table>
<thead>
<tr>
<th>Year</th>
<th>Western States</th>
<th>Idaho</th>
<th>Florida</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941</td>
<td>203,216</td>
<td>97,274</td>
<td>3,419,900</td>
<td>4,922,183</td>
</tr>
<tr>
<td>1942</td>
<td>266,273</td>
<td>114,079</td>
<td>2,984,503</td>
<td>4,818,938</td>
</tr>
<tr>
<td>1943</td>
<td>227,294</td>
<td>108,916</td>
<td>3,274,266</td>
<td>5,369,967</td>
</tr>
<tr>
<td>1944</td>
<td>300,274</td>
<td>112,565</td>
<td>3,436,482</td>
<td>5,200,000</td>
</tr>
<tr>
<td>1945</td>
<td>323,955</td>
<td>123,340</td>
<td>3,814,935</td>
<td>5,399,793</td>
</tr>
<tr>
<td>1946</td>
<td>577,530</td>
<td>312,658</td>
<td>5,280,402</td>
<td>7,168,839</td>
</tr>
<tr>
<td>1947</td>
<td>1,259,727</td>
<td>845,044</td>
<td>6,361,282</td>
<td>9,110,969</td>
</tr>
<tr>
<td>1948</td>
<td>704,316</td>
<td>434,375</td>
<td>7,184,237</td>
<td>9,388,150</td>
</tr>
<tr>
<td>1949</td>
<td>778,598</td>
<td>471,305</td>
<td>6,695,407</td>
<td>8,877,474</td>
</tr>
<tr>
<td>1950</td>
<td>1,044,915</td>
<td>573,044</td>
<td>8,597,227</td>
<td>11,114,159</td>
</tr>
<tr>
<td>1951</td>
<td>1,138,338</td>
<td>782,635</td>
<td>8,211,820</td>
<td>10,775,032</td>
</tr>
<tr>
<td>1952</td>
<td>1,381,338</td>
<td>1,066,678</td>
<td>9,205,133</td>
<td>12,031,213</td>
</tr>
</tbody>
</table>


Since much of Idaho's production is low grade shale, the production of usable phosphorus is relatively less than the figures would indicate. However, nothing can detract from the growing importance of the phosphate industry in Idaho, both nationally as a source of supply of an essential material and locally as a new industrial development which is of great value to the state.

The phosphate boom is of importance not only in itself, but also in its effect on other mineral development. The emphasis on metals has been at least partly eclipsed, and there is now an interest in nonmetals as well. The low-value nonmetals have far narrower cost limits than do metals, but each advance that the phosphate industry makes encourages other development and helps to pave the way for it.

Part of the value to the area of the phosphate development comes from the processing of the rock, which in some cases is carried on in Idaho. The main processes involve treatment of phosphate rock with sulfuric acid (nitric in some areas) to produce either a single or a triple superphosphate for fertilizer use, or treatment of phosphate shale in electric furnaces to produce elemental phosphorus for fertilizers or chemicals.

The production of single superphosphate (18-20 per cent P₂O₅) involves the treatment of 32 per cent P₂O₅ phosphate rock with an equal weight of 65 per cent sulfuric acid. The mixture is heated for 24 hours, then passed into storage piles to remain for several weeks until the reaction is completed. More than 80 per cent of the phosphate fertilizer produced in the country is of this type. Most of the single superphosphate plants are in the East, where small plants can serve local markets. In the West such plants are uncommon because it is uneconomical to transport low-grade fertilizer over the long distances involved. Only 5 of the 202 single superphosphate plants in 1951 were located in the West, but of the 9 triple superphosphate plants in the country, 2 were in the West.
The production of triple superphosphate involves treatment of high-grade phosphate rock with phosphoric acid to give a product containing 43-48 per cent P₂O₅. Phosphoric acid can be produced by the wet process, using 50 per cent more sulfuric acid than in making single superphosphate, or by thermal reduction of phosphate rock in an electric furnace of coke-fueled blast furnace to produce elemental phosphorus then burning the elemental phosphorus to produce phosphorus pentoxide (P₂O₅). Only the wet process and the electric furnace method are used in the West at present.

The elemental phosphorus which may be used to produce triple superphosphate, has many other uses as a chemical raw material. It is produced by treating phosphatic shale mixed with coke as a reducing agent and silica as a flux in an electric furnace. In the Tennessee furnaces where a high-grade charge is used, it requires 7 tons of phosphate rock, 1.5 tons of coke, 2 tons of silica, and 15,000 k.w.h. of electric power to produce one short ton of elemental phosphorus. In Idaho about 10 tons of phosphate shale are required, but the silica required is less than 2 tons due to the natural fluxing properties of the shale.

Since the acid process and the electric furnace process are interchangeable in some uses, much research has been done to find out which process is more economical. The answer hinges on the relative cost of electric power and sulfuric acid. Other points to be considered are that the electric furnace is located near the mine, uses 24 per cent rock, and produces pure elemental phosphorus and from it phosphoric acid, whereas the acid plant is best located at the source of the acid, uses 32 per cent rock, and produces phosphoric acid which is suitable for fertilizer but not for chemical uses. Construction of the acid plant costs about half that of the electric furnace, and the acid plant requires fewer employees.

Geology

General

The main western phosphate deposits are in the Middle Rocky Mountain Province, which is that part of eastern Idaho lying south of the Snake River Plain. However, much phosphate rock is also found north of the Snake River in the Northern Rocky Mountain Province, notably in the Centennial Range on the Idaho-Montana border and around Garrison, Montana.

Southeastern Idaho contains a complete geologic section from Precambrian through Cretaceous. All of the commercial phosphate occurs in the Permian Phosphoria formation and in the equivalent Park City formation of Utah.

The United States Geological Survey has done some excellent work on the Phosphoria and has noted a real difference in the character of the phosphate rocks in Idaho and adjacent Wyoming which indicates that the Idaho deposits were laid down in a mioeosynclinal environment, while deposits to the east were laid down on the platform (McKelvey, Swanson, and Sheldon, 1953, pp. 42-43). The mioeosalinical facies tend to be thicker and finer grained, with more dark shales and chert layers (Swanson, McKelvey, and Sheldon, 1953, p. 9). The variation in appearance of rock in crossing the Idaho-Wyoming border is striking due to the coincidental location of the state boundary very close to the platform edge.
Reserves

The Permian rocks of southeastern Idaho and adjacent parts of Montana, Wyoming, Utah, and Nevada contain some 50 per cent of the phosphate reserves of the country, with Idaho having 43.16 per cent and Utah 13.10 per cent. Florida is the other chief phosphate area with 38.2 per cent of the reserves. (Waggaman and Bell 1950a, p. 270). Exact figures such as these are misleading when one considers minable reserves. Some general statements about reserves will bear this out. McKelvey (1949, pp. 277-278) has stated:

"reserves of phosphate minable under existing economic conditions are large, but by no means as large as earlier estimates would indicate. As a source of phosphate to be mined in the distant future from lower-grade beds and from shaft mines, however, the Phosphoria formation contains an even larger supply than indicated by earlier estimates."

The same author has estimated that the country has 4 billion tons of minable reserves, of which 1.5 billion are in the west, 0.1 billion in Tennessee and the rest in Florida, and that we have 8 billion tons which are not minable today, of which 1.5 billion tons are in Florida and most of the rest is in the West. (President's Materials Policy Commission, Vol. 2, 1952, p. 156). With a peak annual production to date of some 12 million tons (1952), it appears that reserves are abundant both in the West and in Florida, and that beyond that fact, reserve figures have little meaning, as the time that reserves will last depends on future use, which is not predictable with any degree of accuracy.

Accessibility

The over-all picture of the area is one of north-south or northeast-southeast trending mountain ranges in which folding, faulting and thrusting have contorted the Permian beds so that they may lie at any level and in any attitude. The deformation has not caused any extreme metamorphism. The phosphorites of the Permian were deposited over an area of some 135,000 square miles in Montana, Idaho, Wyoming, Utah, and Nevada. (Swanson, McKelvey, and Sheldon, 1953, p. 3).

The Phosphoria formation in Idaho may lie flat at the surface; it may have been eroded off in places where it is assumed to have lain flat; it may dip at any angle up to the vertical; it may be buried several thousand feet below the surface. Thus the formation can and does cut across in inaccessible areas and in attitudes which make economic mining impossible. Where deposits are economically accessible, mining is most easily carried on in flat beds or in beds which dip with the slope of the land surface. Such deposits can be mined by open-pit methods. However, the ideal combination of easily mined beds close to good transportation is rare, and most of such deposits are already in operation or under lease. Thus a point has been reached where ease of mining and ease of access play against one another, and accessible deposits which are costly to mine become as desirable as easily mined deposits which can be developed only with high transportation costs. Since the number of stripping deposits in the area is small, regardless of accessibility, underground operations will probably become the chief producers of the area in the long run.
The Conda mine is the main underground producer in Idaho, and two other underground properties were under development in 1953. The Central Farmers Fertilizer Company was opening up a large deposit in Georgetown Canyon. Here the Phosphoria is folded in a large syncline with the canyon as its axis. A tunnel has been driven from the canyon 2,000 feet into the mountain to strike the Phosphoria. Mining was to be carried on by drifting to the right and left along the formation and taking ore from above entry level. The San Francisco Chemical Company was driving a new tunnel adjacent to the Waterloo mine near Montpelier. In all of these cases, the properties have access to good transportation facilities.

Although the topography of the area is rugged, the valleys are farmed, and there are many settlements. Accessibility is not nearly so much a problem as in the more rugged Northern Rocky Mountain Province.

Prospecting

A knowledge of geology is invaluable in prospecting for phosphate. Most of the reconnaissance work being done is based on Mansfield's report, which contains maps and comprehensive write-ups on most of the phosphate deposits in the southeast part of the state. (Mansfield, 1927). The field work involved in checking phosphate involves stratigraphy and structure along with a familiarity with the area. High grade phosphate which is rock at depth may weather so that it looks like dirt near the surface. Thus a knowledge of the stratigraphic sequence in the Permian and adjacent series is of value in recognizing the Phosphoria. The approximate position of the formation can be worked out at each location from the surface rocks. In the spotting of drill holes to test the formation it is also necessary to take into account weathering, slumping, and landsliding, all of which have a great affect on the formation. Since the phosphatic member of the Phosphoria tends to be soft and to weather easily, it is often recognized even at a distance by the upper chert member, which may be the only outcropping evidence of the presence of the formation. However, the presence of the chert does not assure the presence of the phosphatic member, and the absence of the chert does not have to mean that the phosphatic member is also absent.

The bulldozer and the rotary drill are the most effective and widely used exploration tools.

Mining

When initial exploration and development work leads to the opening of a mine, the variations in the area are sufficiently complex that it is necessary to keep a close check on mining operations. Faulting is very common, in places rendering the rock unsuitable for mining. Local variations in thickness and grade, although not common, may alter the mining pattern. Since much of the rock is very close to the critical grades (32 per cent for acid plants, 24 per cent for electric furnaces) frequent samples must be taken, and the mining cannot be left entirely in the hands of shovel operators and truck drivers.

Transportation

The value of phosphate rock varies from $1 to $5 a ton at the mine, depending upon grade. Thus transportation costs, which can very easily exceed the rock value, serve to limit the area from which rock can be economically recovered within the phosphate field and the area in which mined rock can be marketed.
Facilities and costs

Transportation is by rail where available or where scale of operations warrants spur construction, and by truck where rail transportation cannot be economically supplied. The area is well served by rail lines which pass within a few miles of some of the richest phosphate deposits. The ideal location of some deposits is one of the principal deterrents to the development of other deposits which may be equal in grade and reserves, but which cannot afford to pay the transportation differential that development would assess against them.

A review of the transportation pattern of mines in operation or under development in the western phosphate field will illustrate the relationship between developed deposits and existing rail facilities.

The operations of the San Francisco Chemical Company near Montpelier, Idaho, at Sage, Wyoming, and in the northern Crawford Mountains in Utah, are all located within five miles of existing rail facilities, with good roads or easy terrain between them and the railroads. Underground operations are being developed in Idaho and Utah to get a greater recovery from these readily accessible deposits.

Anaconda’s Conda mine is joined to the main line of the Union Pacific at Soda Springs by an 8-mile spur which was paid for by the mining company. The Conda mine was developed about 1930 as an underground operation. However, some open-pit mining has been carried on in recent years.

The Gey mine of the J. R. Simplot Company, 16 miles east of Fort Hall, is joined to the north-south line of the Union Pacific by a 23-mile spur which is being paid for by the mining company. Open-pit reserves in this area are very large, and both high-grade rock and low-grade shale are mined from them. Normally this mine is the largest tonnage producer in the West. The Simplot Company is also opening a small mine in Utah and developing leases in the Centennial Range on the Idaho-Montana border.

Monsanto Chemical Company is mining on the Ballard property, 18 miles north of Soda Springs. Rock is trucked over a road which is partly state highway and partly private. Mining and trucking is done on contract by Morrison-Knudsen. The furnaces which are fed by the mine are north of Soda Springs on the Conda spur, which is used on a rental basis.

Western Fertilizer Association has under development a stripping property some 8 miles east of the Ballard mine. Plans called for moving the rock to Soda Springs by truck, a distance of some 36 miles. This is the most remote deposit from which definite production was planned. It was reputed to be one of the best and largest open-pit deposits in the area.

Central Farmers Fertilizer Company is developing its underground property in Georgetown Canyon, about eight miles from the main line of the Union Pacific. Plans call for a rail spur up the canyon to the vicinity of the mine site.

To complete the western picture, the mines near Garrison, Montana, supplying Consolidated Mining and Smelting Company at Trail B. C., and
Morose, Montana, supplying Victor Chemical Corporation at Silver Bow, near Butte, are both located close to existing rail lines.

Transportation costs at present seem to limit areas of economic development roughly to within 10 miles from existing rail lines for underground development, and to within 20 miles for open-pit operations. These limits will be widened in time as good deposits within them are depleted and as new companies enter the field. There is much phosphate beyond these ranges which will be developed ultimately, but at a higher transportation cost. Spur construction in the phosphate area might be difficult in places, but most parts could be served by rail. The limits on rail transportation are financial rather than physical.

The cost of building transportation facilities to serve mines tends to restrict areas of production within the phosphate field. Above and beyond this, the area in which western phosphate can be marketed is restricted by the freight charges which must be paid in shipping the material to the consumer.

Transportability and plant location

Phosphate rock in its raw form is a low-value material. Mine run high-grade rock (32 per cent P₂O₅) is valued at about $5 a ton. However, through processing into one or another of the fertilizer or chemical forms, the rock gains in value so that it can be shipped more readily. Single superphosphate containing 18 to 20 per cent P₂O₅ is the most widely used form of phosphate fertilizer in the country but is produced mainly in the southeastern states in a great many small plants serving local markets. (Adams et al., 1952, p. 12). Triple superphosphate and elemental phosphorus have a much higher usable concentration of the element, thus a much higher value and a greater degree of transportability. To transport the equivalent of one ton of elemental phosphorus in other forms it would be necessary to move about 2.29 tons of P₂O₅, 5.7 tons of 45 per cent triple superphosphate, or 12.7 tons of 18 per cent single superphosphate.

As a result there is a tendency to favor construction of processing plants near the site of the rock deposit to minimize transportation costs. The large electric furnaces constructed at Soda Springs and Pocatello for the manufacture of elemental phosphorus were located to take advantage of this. The tendency can also be seen in the location of the fertilizer plants at Wendell and Pocatello.

The triple superphosphate plant of Gates Brothers at Wendell is located in a market area. It receives its rock from the San Francisco Chemical Company, about 100 miles away, and its acid from Salt Lake City, some 300 miles away. This plant was closed in bankruptcy in the summer of 1953 due in part to the high cost of transporting raw materials to Wendell. Reorganization plans called for a new plant, probably near either rock or acid.

The fertilizer plant of the J. R. Simplot Company at Pocatello originally produced single superphosphate. The competitive marketing area for this low-value fertilizer was restricted by transportation costs, and the plant was recently converted to produce triple superphosphate which can be shipped at the same rate as single, but can be marketed over a wider area because of its higher concentration of usable material.
Although processing generally should be near the mine, some considera-
tion must be given to the costs of bringing other raw materials to the pro-
cessing center. Where the electric furnace process is used, electric power
can be transported more cheaply than rock, so the plant tends to be located
near phosphate deposits. In the case of acid plants, rock can be transport-
ed more cheaply than acid, which requires special care and handling, so
plants tend to be constructed at the source of the acid. Since Idaho, with
the possible exception of the Coeur d'Alene district, has no large source of
sulfuric acid, few such plants will be located in the state. The Gates
Brothers and Simplot plants were located in the state for reasons other
than economy of collecting raw materials. It will be noted that rock moves
to acid from Conda to Anaconda, from Garrison to Trail, and from Sage and
Montpelier to the Salt Lake City area and to Tacoma. The acid plants under
construction are in the Salt Lake City area, where acid from smelters and re-
fineries is available.

Electric furnaces appear to be the type of plant which will be lo-
cated in Idaho. Except for plants supplying a local market, most acid
plants using Idaho rock will be located in other states. The electric
furnaces may become competitive with acid plants if acid prices continue
to rise and power prices stay low. With cheap power Idaho might avoid
exporting most of its rock as raw material for industry in other states.

Market

Idaho phosphate deposits have been known since the early part of the
century, and considerable information has been available on them since
the publication of the Mansfield report in 1927. Although some production
did take place after 1906, it was mainly to supply part of the small western
market. A significant upsurge in 1946-47 was stimulated by foreign markets,
principally in Japan and production has continued high to supply a growing
domestic market.

The current market in Idaho for phosphate rock has three principal
forms:

(1) A small amount of high-grade phosphate rock is
    marketed in some of the midwest states for direct
    application to the soil. Direct application would
    be far more widespread except that only certain
    types of acid soil can make use of the phosphorus
    in untreated rock.

(2) Superphosphate fertilizer is manufactured by treating
    high-grade rock with sulfuric acid.

(3) Elemental phosphorus is manufactured by treating low-
    grade shale in an electric furnace. The pure product
    obtained in this process is used in producing detergents
    and other chemicals, and can also be used for fertilizer.
### TABLE 4 - Market use for western phosphate rock - 1952

<table>
<thead>
<tr>
<th>Form</th>
<th>Long Tons</th>
<th>Per cent of Total</th>
<th>Source Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superphosphate</td>
<td>291,097</td>
<td>27</td>
<td>Idaho and Wyoming</td>
</tr>
<tr>
<td>Phosphoric Acid, Elemental</td>
<td>478,138</td>
<td>44</td>
<td>Mainly from Idaho</td>
</tr>
<tr>
<td>Phosphorus, Ferro-phosphorus</td>
<td>101,878</td>
<td>9</td>
<td>Mainly from Wyoming</td>
</tr>
<tr>
<td>Direct application to soil</td>
<td>219,192</td>
<td>20</td>
<td>Mainly from Montana</td>
</tr>
<tr>
<td>Exports*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


*The exported rock goes mainly to Trail, B. C., for conversion to superphosphate fertilizer.

Furnace products are not at present used as fertilizer, although they can be. In the long run it is expected that fertilizer products will continue to be the major destination for western phosphate and that some of the elemental phosphorus produced in electric furnaces will be used as fertilizer material (Bell and Waggyman, 1950, p. 286).

The west must increase its use of fertilizer if crop yields are to be maintained. In the 17 western states in 1946 the application of P₂O₅ was about half the estimated need and less than one quarter of that taken from the soil by crops (Bell and Waggyman, 1950, p. 287).

### Effect of freight rates on markets

As in other cases where the product has a relatively low value per ton, the natural market area of each deposit is limited to a considerable extent by the area which can be served more cheaply by competitive deposits. In the case of the western deposits, the chief competitive area is in Florida. Extensive surveys have been carried out by the federal government to determine the natural market for each producing region (Bell and Griffith, 1947; Conyers, 1952; Scruggs, 1957). Conclusions reached in 1946, which have not been materially altered by freight rate changes since that date, indicate that Florida and the western states divide the country between them roughly along a line from Chicago through Kansas City to the western border of New Mexico (Bell and Griffith, 1947, Fig. 9). Thus each producing area has a large natural market, and distances from the western phosphate area to important markets may be as great as 1,500 miles (Bell, 1950, p. 489). A division on the basis of freight rates alone assumes that all other costs are equal, which is not the case.Mining costs in the west tend to be higher than those in Florida (Waggyman and Bell, 1950a, p. 270), and the differential may increase as the more easily mined deposits are exhausted. The short mining season for open-pit mining and the added expenses due to winter operation increases the cost differential which would tend to broaden the natural market for the Florida deposits.
Captive mines

At this stage the problem is not how to capture all of the natural market area, but how to supply the demand which now exists and how to stimulate new demand in areas which can be served with definite advantage from the west. With the chief fields of demand the fertilizer and chemical industries, there has been in the post-war years a strong trend towards integration downward to raw materials by organizations interested in both of these fields. In almost every case there is some connection between mine and processing plant. Anaconda and Monsanto operate their own mines to supply their own processing plants, Anaconda to produce a marketable fertilizer, Monsanto to produce elemental phosphorus which is a raw material for further company products. Simplot produces acid grade rock for its own fertilizer plant and supplies furnace shales for Westvaco's elemental phosphorus plant on a contract basis. The most loosely-knit arrangement is that of the San Francisco Chemical Co., which owns some mines but is tied in to some of its chief markets through leases under which it mines ore from claims owned by the fertilizer companies which it supplies with rock. The San Francisco Chemical Company sells rock on the market in addition to its contract sales, and is the only company currently operating in the state which has as its primary business the mining and selling of phosphate rock. Other companies sell some rock on the market, but as a side line.

One of the greatest potential markets is the farm area of the midwest, and development is underway to supply this demand, again through captive mines. The Central Farmers Fertilizer Company, a combination of cooperatives in the midwest and northcentral states in 1953 was developing a mine in Georgetown Canyon for the benefit of member cooperatives. The potential demand of the 12 northcentral states is estimated at over 640,000 tons of P₂O₅ a year (Bell and Griffith, 1947, Fig. 2), which is the equivalent of over 1,400,000 tons of triple superphosphate.

A second cooperative organization, Western Fertilizer Association was planning production beginning in 1954 to serve the market in the 6 western states. Both of the cooperatives planned ultimately to produce elemental phosphorus, and their plans hinged to some extent upon the availability of low-cost power.

Research

In its principal uses there is no substitute for phosphorus, and as a source of phosphorus, Florida and the western phosphate field must serve the country. Indeed, phosphate is being substituted for other materials as research finds new uses which lead to an expanding market, as in the case of the detergent cleansers which have partially replaced soaps. Market research will continue to play a large part in broadening the field served by the phosphate industry and in adding stability through variety, but the chief need for phosphate and the chief market over the years must continue to be agricultural. Here research must improve upon the methods of satisfying existing markets, in some cases through stimulating use of fertilizer on lands which need it, or through improving distribution and marketing techniques, in other cases through devising new and improved products.

Power

Power is important in the discussion of the western phosphate industry because one of the principal processes, the electric furnace process is a
large consumer of power, and also because the large potential power demand created by electric furnaces has stimulated much interest in development of low-cost power in the area.

The part that low-cost power plays in Idaho industrialization is readily seen. Low-cost power will lead to the development of processing plants near the deposits in Idaho. If the alternative sulfuric acid process is used, the plants will be located at the acid source, currently at Salt Lake City, Anaconda, and Tacoma.

Power for the phosphate industry is electric power and more especially, hydroelectric power. The electric furnace requires some 13,000 kilowatt hours for each ton of elemental phosphorus recovered. In this requirement the phosphorus industry approaches the power requirement of the aluminum industry—6 1/2 kilowatt hours for each pound of phosphorus, as against 9 for aluminum.

Electric furnace plants now located in the west include Westvaco, which operates four furnaces at Pocatello; Monsanto, which has one large furnace at Soda Springs and was planning a second; and Victor Chemical Company with a furnace at Silver Bow, Montana. Each of these plants produces elemental phosphorus, primarily for the high-value chemical market; consequently power costs are a relatively minor factor in their accounting.

The Idaho plants obtain power from the private utilities serving their area, Westvaco from the Idaho Power Company, and Monsanto from the Utah Power and Light Company. As of August 1952, their rates were between four and five mills per kilowatt hour, (Salt Lake City Tribune, Aug. 24, 1952), or considerably above the government's Bonneville Power, which was between 2 and 2.5 mills at that time.

The effect of power costs on total development is difficult to assess. There is little effect on plants which serve a chemical market, because they have a high value product and because they are established with reasonably low rates. New plants in the area would not likely receive such favorable power rates, because new power plants are more expensive and new sites difficult to find.

The cooperatives which are developing mines in Idaho hope to produce elemental phosphorus by electric furnace for the fertilizer market. The main advantage of this process is that it allows the mining and use of the great thicknesses of furnace shales along with the high-grade rock. The cooperatives will require lower power costs, on the order of four mills, to be able to produce elemental phosphorus for fertilizer use economically, and they are hoping that federal power development in the area will give them such low rates.

Continued development of electric furnaces in the area will require the building of coal-fueled generators, using Utah and Wyoming coal. Phosphate smelting, using atomic generated electricity, is considered a possibility in Florida. (Schurr and Marschak, 1950, pp. 124-134), but is unlikely in the west where low-cost hydroelectricity is available.

### Government

Federal government land policy

During the first few years of the century the most accessible phosphate deposits were staked and patented. In 1908 the federal government withdrew
a large area of phosphate land from entry; there have since then been some changes in boundaries, but this land is still not open for staking. The Mineral Leasing Act of 1920 made provision for leases on government land, and since that date, and particularly since World War II, several deposits have been leased.

Under the present leasing law, the Bureau of Land Management puts sections of the phosphate reserve up for competitive bids or, in some special cases, allows noncompetitive leases. The prospective lessee must post a minimum bond of $5,000 with his bid. If successful, the lessee pays for the lease at his bid rate and must make specific expenditures for exploration and development in each of the first three years of the lease. The lease sets up a minimum annual production from the property beginning with the fourth year, or allows payment of a royalty in lieu of production. A royalty which is usually 5 per cent of gross value of product is paid on all production. Leases run for 20 years, after which they may be readjusted and renewed. Where authorized in the lease, development expenditures and annual production quotas may be met on other leased properties controlled by the lessee. No individual or company can at one time hold leases on more than 5,120 acres in one state or 10,240 acres in the country.

This system of leasing is very different from the method of obtaining mineral rights on other government lands, and approaches the systems being developed in other countries whereby large tracts can be reserved for exploration. The law governing such leasing is included with oil and gas leasing regulations and resembles them much more closely than it does mineral rights. Those who fear that changing the mining laws would hamper development can look to the western phosphate area as an example of how new laws might work. The companies operating under government leases might prefer to own their claims outright and to be freed from compulsory expenditures and royalties, but such regulations have value to the area in stimulating development.

The Ballard property of Monsanto Chemical Company and part of Anaconda's Conda mine are on the phosphate reserve. Western Fertilizer Association is developing a mine on the reserve, and was obligated to begin production in 1954 or pay royalties in lieu of production to hold its lease. Other leases are under preliminary development throughout the area. The Gay mine of the J. R. Simplot Company is on the Fort Hall Indian Reservation, and is leased from the government under a different arrangement. It does not count toward the acreage limit of the company.

Federal aid

The phosphate reserve was examined and evaluated by the U. S. Geological Survey and this work resulted in the publication in 1927 of "Geography, Geology, and Mineral Resources of Part of Southeastern Idaho," by George R. Mansfield. This work has been used as the basis for most of the exploration in the current development, and its information has been found to be remarkably accurate. The Survey has continued to work in the area, getting more detailed information and the results of this work are giving much new insight into the geology of the area.
The U. S. Bureau of Mines has aided in phosphate processing, particularly in the recovery of minor elements such as vanadium and uranium from the phosphate rock. The Bureau of Land Management controls the leases on phosphate land. Bonneville Power Administration, through its Market Analysis Section, has made studies of the market for phosphate and in the course of these studies has compiled a vast amount of information of value to the industry.

Federal taxes

Most of the plants in the state have not been in operation long enough to get their tax pattern well established. Heavy development during the last few years has been aided in some cases by accel rated tax amortization. Not all plants apply for or get accelerated tax write-off on their new investment, and plants which do not get such benefits operate under a handicap, since they must compete with plants which can take advantage of such amortization. The industry which has developed in southern Idaho as a result of phosphate will in time become a significant source of tax revenue.

State policy

Since the phosphate development is so closely watched over by the federal government, the state has relatively little to do with the industry. Actually the facilities of the state which might aid industry are better designed to serve small operations. The Idaho Bureau of Mines and Geology has done some work on phosphate beneficitation. The state tax policy on phosphate development is currently being clarified and should be well formulated by the time the development stabilizes.

Local policy

County and municipal officials look upon the phosphate development with great favor, particularly when large processing plants valued in the millions of dollars are located in their area and added to their tax base. Revenue increases not only through the property taxes, but also through the net profit of mine tax and through the general economic stimulus to the community.

The complex nature of the phosphate operations has raised some problems in taxation on the county level which as yet have not been completely worked out. These stem from interpretation of "net profit" under the Net Profit of Mine tax and can be best explained with examples. The only integrated phosphate producer which is well established for tax purposes in the Anaconda Copper Mining Company. This company mines phosphate rock in Caribou County, and ships it to Montana, where it is processed. The "net profit" on which a tax is paid in Caribou County is based on the profit on the sale of fertilizer and thus includes a profit on value added to the rock in Montana. This is the way that the law is interpreted by the company. If this interpretation were applied to the other operators in the field, it would require that the tax be paid on the final profit resulting from treatment of phosphate rock by

*Letter from K. B. Frazer, Assistant Treasurer and Assistant Secretary, Anaconda Copper Mining Company, Butte, Montana, November 12, 1953.
company which mines it. Thus Monsanto Chemical Company would pay a tax to Caribou County, where its mine is located, on the profit added to the value of phosphatic shale by processing in its plants. This would include not only the initial processing to elemental phosphorus, which takes place within the county, but also the further processing which takes place in company plants in Missouri and Illinois. Westvaco, with similar interests, would pay no such tax, since it does not operate a mine, but purchases shale from other producers. Although the law can be interpreted as Anaconda does, other interpretations are allowed. Thus it is likely that the new companies will base their "net profit" on a figure related to the value of the material mined.

The whole phosphate development is so much larger and more complex than past mineral developments in the area that it may force some reinterpretations of the state and county tax laws when problems are encountered which the laws were not designed to handle.

Other factors

Climate

The climate of the phosphate area restricts mining during the winter. Open-pit mines operate during the summer, usually from June until about November, and stock-pile enough rock and shale at the plant or railroad to supply the winter's demand. Underground mines may operate throughout the year with minor inconveniences in handling and shipping ore.

Water

Water supplies in most parts of the Idaho phosphate field are sufficient to supply any mining and processing needs. The deposits are in dry areas, but little water is required in mining. Where such water is available in local streams, it is usually tied up for use in irrigation, so wells must be drilled.

The main use for water is in benefication of phosphate rock, which is done through washing where water is available. Where grade is critical, benefication may bring rock up to grade, cutting down on mining expenses and increasing reserves. Washing is currently carried on by Anaconda both at the mine and at the fertilizer plant at Anaconda, Montana. The Montana washing plant raises the phosphate content of rock from 30.5 per cent to 33.7 per cent and cuts silica from 13.0 per cent to 7.9 per cent. (Carp, 1949, p. 283). The mine of San Francisco Chemical Company at Sage, Wyoming, also beneficiates rock, but since the scarcity of water in the area and the very cold winter would make use of water difficult, a system of air classification has been evolved which gives satisfactory results.

Labor

Since most of the operating properties are readily accessible by road, and no more than 30 miles from towns, there is relatively little trouble getting workers, and there is no need to supply them with special services.
Good transportation has increased the mobility of labor. When the Conda mine was developed in 1920, roads were poor and automobiles a luxury. Although the mine is only 8 miles from Soda Springs, it was necessary for the company to build a town, complete with store, school, and normal services. Today the men who operate Monsanto's mine some 12 miles beyond Conda arrange for their own accommodations; there are no accommodations at the mine. The seasonal nature of open-cut mining does not enhance stability in the work force, but the labor pool in the area can handle the summer's increase with no trouble.

Competition

Since most of the companies operating in the phosphate field supply contract markets, there is little active competition among them. There is in its place a remarkable degree of cooperation through which companies trade geological information and buy ore from one another when their supplies are interrupted. Such cooperation works to their mutual advantage even though on some higher level the companies may be in active competition. There is, however, active competition in the bidding on leases.

Raw materials

The principal raw materials which must be combined with phosphate rock are sulfuric acid, in the case of the wet process, and coke, silica, and electric power in the electric furnace. Silica is obtainable locally from some of the high-grade Cambrian and Ordovician quartzites and coke from the oil refineries in the Salt Lake City area. Sulfuric acid and power are the raw materials which can have the greatest effect on processing.

Sulfuric acid in the western phosphate area is obtained as a by-product from the smelters at Anaconda, Montana; Garfield, Utah; and Trail, B. C. Some spent acid, which is a waste product of oil refining, is also available from Utah, and has been used in the plant at Wendell, Idaho, but the quantity available is not enough to run a large plant. The use of acid from elemental sulfur has not been important in the area, although it should be noted that most of the acid used to produce normal superphosphate in the East is produced at plant site from elemental sulfur. Sulfuric acid cost has risen considerably in the last few years. Bell in 1948 placed a conservative price at that time at $6.50 a ton (Wagaman and Bell, 1950b, p. 280). The market price in 1953 was $18 a ton, with contract buyers probably paying about $10-$14 a ton. The freight rate, which would add $6-$10 a ton for transportation to southern Idaho, makes delivered cost of sulfuric acid about $20 a ton in the state. Since phosphate rock can be moved from the deposits to the Salt Lake City area for about $3.50 a ton, it is apparent why plants tend to be located at the source of the acid rather than at the mine.

It is possible to produce a suitable fertilizer using hydrochloric or nitric acid in place of sulfuric acid. (Hill, 1950, pp. 55, 86, 86B), and plants using such substitutes may be developed in the west. However, these acids are not plentiful in the area either. Potential sources of sulfur for further fertilizer development are in the scur gases and crude oils and in low-grade fertilizer deposits of Wyoming. A new plant was being put into operation at Kellogg, Idaho, to recover sulfur from the smelting of lead-zinc ores. As an ultimate control on acid price and supply, there
is the possibility of shipping elemental sulfur from the Gulf Coast and making acid at the mine.

The cost relationship between fertilizers produced by the acid process and the electric furnace process has been worked out, and it would appear that power at 3 mills per k.w.h. is equivalent to acid at $10 a ton. (Utah Economic and Business Review, 1950, p. 145). This is assumed to be 100 per cent sulfuric acid and, if so, it would be about equal to figures in Table 5:

TABLE 5 - Prices of Acid and Power Which Equalize Production Costs

<table>
<thead>
<tr>
<th>Acid (50° Be., or 62.2%) (dollars per ton)</th>
<th>Electricity (mills per k.w.h.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.50</td>
<td>3.2</td>
</tr>
<tr>
<td>7.00</td>
<td>3.4</td>
</tr>
<tr>
<td>7.50</td>
<td>3.7</td>
</tr>
<tr>
<td>8.00</td>
<td>4.0</td>
</tr>
<tr>
<td>8.50</td>
<td>4.2</td>
</tr>
<tr>
<td>9.00</td>
<td>4.7</td>
</tr>
<tr>
<td>10.00</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Source: Schurr, op. cit., p. 131.

If the choice rests purely on these costs; the acid process is currently cheaper for fertilizer production. However, ore reserves and the lower unit costs of transporting elemental phosphorus may influence the decision of the producers.

By-products and co-products

The phosphate shale member of the Phosphoria formation in southern Idaho normally has two beds which run 30 per cent or higher in P₂O₅ and which can be mined and washed to make suitable charges for acidulating plants. One or the other of these beds may be missing, or only one bed may be mined. The thickness of the high-grade beds varies up to 7 feet. This is the only material which was mined prior to construction of the electric furnaces in the area.

Electric furnaces require a siliceous charge, and if high-grade rock is used, silica must be added. The low-grade shales are largely self-fluxing and are preferred for furnace use. The ratio of shale to rock throughout the area averages about three to one, so the use of shales increases the reserves of the area greatly. The co-production of rock and shale also tends to lower mining costs, as in open-cut mines at least, the shale must often be moved in order to reach the rock. Complete co-production has not yet been attained in the region, as the market for the two products is not in balance, but the economic advantages of the total utilization of available phosphate will encourage such development.
By-products which may be recovered from phosphate rock include fluorine, vanadium, and uranium. Vanadium pentoxide averages 0.5 per cent and fluorine averages about 5 per cent in high-grade rock, uranium oxide 0.01 to 0.02 per cent in some of the phosphate shales (Larsen and Peters, 1953, p. 2427). At present vanadium is recovered by Anaconda. The Bureau of Mines is working on processes for recovering these by-products, which constitutes an important reserve if they are needed (Banning and Rasmussen, 1951, p. 2). Ferrophosphorus is recovered as a by-product of the electric furnace process. Samples tested by the Bureau of Mines contained 58-61 per cent iron, 24-27 per cent phosphorus, 3-5 per cent vanadium, 3-6 per cent chromium, and about 1 per cent nickel. Ferrophosphorus is marketed to the steel companies where it commands a price of approximately $65 a ton.

Gypsum is recovered as a by-product of acidulation and may add to the value of the process, though it is not marketable at present because of its quality.

Technology

Technological developments in mining methods and in markets are of great significance in the present upsurge in phosphate production. The development of refinements in earth-moving equipment during the last 15 years has revolutionized mining of phosphate. With the first western phosphate stripping operation by San Francisco Chemical Company in 1945, a new period of development was entered upon, and today more than 80 per cent of the phosphate rock in the state is recovered from open pits.

Development of detergents and other chemical uses has broadened the demand for phosphate products greatly, giving the industry increased markets and increased stability. Although these are the most significant developments, technology has paced the industry throughout its present expansion.

OTHER MINERALS

The tremendous interest in the phosphate boom has made it possible to discuss most of the possible economic factors as they affect the evaluation of a mineral resource. These factors are felt in different manner and in different degree in the development of other mineral deposits in southern Idaho. To illustrate these effects, case studies of cobalt, lead, zinc, copper, fluor spar, barite, and pumice are here reported.

Cobalt

Cobalt is high on the list of critical minerals which are in short supply in this country and essential to defense. The demand for cobalt has increased greatly, particularly in alloys for jet engines and other high-temperature equipment. Only a minor part of this demand has been met by domestic production. Because of its vital uses and low domestic supply, cobalt must be developed in this country in order to achieve a maximum self-sufficiency should foreign sources be cut off.

Cobalt deposits in central Idaho are under development and are expected to become the major domestic source of the mineral. The main deposits are
held by the Calera Mining Company, a subsidiary of the Howe Sound Company. Although we are still far from self-sufficiency, we are becoming less reliant on foreign sources.

The national consumption and production of cobalt in the post-war years is shown in Table 6.

<table>
<thead>
<tr>
<th>Year</th>
<th>Produced in U.S.</th>
<th>Consumed in U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946</td>
<td>518,378 lbs.</td>
<td>4,105,027 lbs.</td>
</tr>
<tr>
<td>1947</td>
<td>645,295</td>
<td>4,154,722</td>
</tr>
<tr>
<td>1948</td>
<td>687,464</td>
<td>5,019,224</td>
</tr>
<tr>
<td>1949</td>
<td>521,856</td>
<td>4,701,926</td>
</tr>
<tr>
<td>1950</td>
<td>809,328</td>
<td>8,283,408</td>
</tr>
</tbody>
</table>

The demand was expected to increase in 1953 to 12,650,000 pounds, which would be supplied by the Belgian Congo (7,500,000 pounds); French Morocco (250,000 pounds); Cobalt, Ontario (750,000 pounds); Blackbird District, Idaho (3,000,000 pounds); and Fredericktown, Missouri (500,000 pounds) (Beall, 1951, p. 24). This estimate does not mention production from the Cornwall, Pa. magnetite deposits of the Bethlehem Steel Co., which have been among the principal domestic producers in the past.

The Idaho production has not lived up to this estimate, primarily because of refining problems. However, the Idaho mine plant was designed for production of more than 3 million pounds of cobalt a year, and the plant was expected to reach this capacity when the refinery was ready to treat concentrates in quantity.

It is important to note that even with the projected production taken into consideration, our domestic supply is less than one third of United States needs.

Geology

The presence of cobalt in the Blackbird District, Lemhi County, on the eastern edge of the Idaho batholith, has been known since early in the century, and the deposits have been subjected to intermittent development. The area is extremely rugged, and although access to it by individuals provides no problem, equipment and ore can be moved only with considerable expense and difficulty. Since the area supports little economic activity outside of mining, development expenses must be assessed against the ore deposit. Thus the general geology of the area, as reflected in topography and economic activity, is one of the major obstacles to development of the cobalt deposits.

Local outcrops indicate the presence and location of some of the main ore bodies, in which cobaltite and chalcopyrite have been concentrated in
shear zones in Precambrian quartzites and argillites. The ore runs about
0.7 per cent cobalt and 1.6 per cent copper. In extending the reserves of
known deposits and locating new deposits, there have been excellent results
in experimentation with some of the newer prospecting methods. Geochemical
testing of soil and stream sediments through the cobalt area pointed to pre-
viously unlocated mineralized zones (Hawkes, 1952, p. 1260). Geochemical
prospecting may prove of particular value, as it does not require bulky and
expensive equipment in the field.

Exploitation in the area adjacent to known deposits has led to the
discovery of more cobalt, so that the area may have greater potentialities
than are at present indicated.

Transportation

The Blackbird District is in an area which cannot be economically
served by a railroad. The nearest railhead is at Mackay, 107 miles from
the mine. Salmon, some 45 miles from the mine, was served by the Pittsburgh
and Gilmore Railroad, a branch of the Northern Pacific, but this route
was discontinued and the tracks removed in 1939, before the present cobalt
development was begun.

At present the ore is concentrated at the mine, and concentrates are
trucked 107 miles to the railroad at Mackay in special containers which are
mounted on semi-trailers. At Mackay the concentrates are transferred to
rail cars and shipped to Garfield, Utah, for refining.

The road from Mackay to a point 8 miles north of Challis is a state high-
way which is adequate for any planned trucking. Most of the remaining
distance to the mine is through the Salmon National Forest and during the
early stages of development was served by a single track road, open only
during part of the year. In order to bring the area quickly into produc-
tion, funds were appropriated under the Defense Highway Act of 1941 for
improvement of this section of the road. Some $227,000, about $5,000 per
mile, was spent in making the old road a good two-lane gravel road. Main-
tenance is shared by the Forest Service and the mining company.

Since the ore is low in grade (0.7 per cent Co and 1.6 per cent Cu)
initial concentration takes place at the mine, and a 16-17 per cent cobalt
concentrate is shipped to Garfield. When full production is reached,
about 150 tons of concentrates will be shipped each day at a transportation
cost of $9 per ton from mine to railroad. This cost includes the mine's
share of the road maintenance.* It should be noted that these concentrates
have a high value, as a ton of 16 per cent cobalt concentrate contains 320
pounds of cobalt, which at the current market price of $2.60 per pound (Nov.
1953) is valued at $832. Thus transportation costs are a relatively small
part of the value of the mineral product.

*Letter from E. B. Douglas, Manager, Blackbird Division, Celereg Mining
Company, December 14, 1953.
Market

The market for cobalt presents no problem. All of the planned domestic production adds up to less than one third of the present national demand. With the increased use of cobalt in jet engine alloys and in other military and civilian uses for which the metal has no substitute, the market is expected to remain well above domestic supply.

The need for an assured domestic supply of cobalt is one of the chief reasons for the rapid development of Idaho cobalt deposits. To encourage development and to remove the market hazard, the government has guaranteed to purchase at the market price a large part of the cobalt produced from the deposits under development (Minerals Yearbook, 1950, p. 394) during the first 5 years of production. At the government's urging, the company has increased the size of its plant and refinery by 50 per cent to give 3 million pounds a year, rather than 2 million, as originally planned.

Government

Government need for a firm domestic supply of cobalt should be a strong enough force to overcome any adverse factor. The government has had geologists working in the Blackbird District intermittently since 1942, and through them has provided much of the information on which development is based. The Bureau of Mines has worked on the problems of cobalt metallurgy. Funds have been provided through Defense Minerals Exploratory Administration to aid in discovery and development of ore by companies working adjacent to known deposits. Purchase contracts have been written up to assure a market for cobalt production, and although at present there is every reason to expect a ready natural market for cobalt, this assured market is an added encouragement to production.

The government's assistance in the building of the road to the mine, which is unusual at least in Idaho, stresses the strategic importance placed on the deposits.

As normal production had not begun in 1953, the effect of taxation on the various levels was yet to be felt. The federal government makes generous allowances to companies producing critical materials through accelerated write-off and other methods. State and local taxes do not allow these concessions and thus will take some 6 to 8 per cent of the net profits of the mine.

It will be of interest to note the effect of this development on the tax base of Lemhi County. In 1950 the county had a population of 6,278 and an assessed property valuation of $5,059,734. The mine development is reported to have cost more than $6 million (U. S. House Rep. Ser. No. 59, 1951, p. 43), and much additional building and development in the townsite and adjacent areas has followed the opening of the mine, all of which will add to the assessed valuation of the county.

Other factors

Climate. The cobalt deposits lie in the rugged mountains which border the Idaho batholith on the east. The climate is not as severe as might be expected, but snowfall is heavy and the winters are long. The snow need not
hinder mining, but hauling of ore during the winter meets certain difficulties. For example, the frost goes out of the roads at the various altitudes between 5,000 and 7,500 feet at various times. Thus frost heaving is spread over a period of two or three months rather than a relatively short period as in level country.

Labor. The cobalt operation in Idaho was planned as a permanent development with about 300 men on the payroll. At first there were no living facilities of consequence in the area, and the company had to supply water, sewers, schools, stores, and even entertainment. The degree to which it is successful will determine to some extent the stability of its labor force. The policy of the Calera Mining Company has been constructive, and its community development has been one of the best in Idaho to date. The company has built community facilities, has aided employees in building their own homes through providing lots, has assisted in buying materials, and has advanced up to $2,500 toward the cost of each home. The homes which are being built are not stereotyped company houses, but rather show the individuality of their owners, who are often the builders.

The community named Cobalt will be large enough to be self-sufficient socially. With a high percentage of home owners, there should be good stability of labor. The system used here of helping employees to own homes rather than supplying company towns makes for a more livable community.

Competition. With today's market for cobalt, it does not appear that there will be serious competition for the domestic market. Once the Idaho deposits of Calera Mining Company begin operation, with the aid of government subsidies, they should be able to compete successfully with foreign sources. Some competition may be expected from other producers. Among these is the Northfield Mines, Inc., which is exploring claims adjacent to those of Calera. Further competition will come through more intensive byproduct recovery of cobalt such as those by Bethlehem Steel Company, which recovers cobalt from its magnetite mine at Cornwall, Pa., and St. Louis Smelting and Refining Company, from a complex copper-lead-iron-nickel-cobalt ore near Fredericksburg, Mo. Production from these deposits was not expected to exceed 1,250,000 pounds in 1950, or some 10 per cent of the anticipated demand. (Beall, 1951, p. 17).

There is some possibility that other materials may be substituted for some of cobalt's uses. An example is the proposed substitution of finely-divided iron powder for much of the cobalt used in magnetic alloys, which in 1950 accounted for 28 per cent of the U. S. cobalt consumption. (President's Materials Policy Commission, Vol. 4, 1952, p. 13).

Co-products. About twice as much copper as cobalt is recovered from the cobalt ores, but due to the difference in price (cobalt $2.60 per pound, copper 92.6 cents per pound), cobalt is the principal metal. Some costs of production can be assessed against the copper. Some of the lodes in the area also contain recoverable gold and minor amounts of other minerals. (Anderson, 1943a, p. 15).

The Blackbird mine became the largest producer of copper in southern Idaho in 1951. With a copper-cobalt ratio of about 2:1, the mine will produce some 6 million pounds of copper annually in reaching its goal of 3 million pounds of cobalt. This will be greater than the total Idaho copper
production during any of the years since the first World War. However, Idaho production will still be small when compared with such states as Arizona, Montana, and Utah.

**Technology.** The key to cobalt production in Idaho has been the development of a new hydro-metallurgical process by the Chemical Construction Company, which involves acid leaching of sulfide concentrates followed by precipitation of the cobalt as a metal powder by hydrogen under pressure. The problems involved in putting this process into operation for the first time were the main factors in the delay in production in 1953. Difficulties in converting from a pilot plant to an operating plant are not unusual.

Present status and future possibilities

While the Calera Mining Company operation was being held up in 1953 by technological difficulties in the refinery at Garfield, Utah, production at the rate of 3 million pounds of cobalt per year was expected ultimately.

Technological advances and facilities created in developing the Calera deposits will aid in making cobalt recovery possible from other deposits in the area. The whole cobalt area should see a build-up with the possible development of copper-gold mines. Anderson (1943a, pp. 17-33) notes that cobalt extends through an area of 25 square miles. He describes some 18 prospects which have had development work done on them. Much of the immediate area is held by Calera Mining Company* but other companies are actively prospecting in adjoining regions. Thus the development of one cobalt deposit on a large scale has completely changed the potentialities of an old mining district.

**Lead, zinc, and copper**

Although lead, zinc, and copper occur at many places in southern Idaho, the area's production is completely overshadowed by that of the Coeur d'Alene District, which in 1952 mined 92 per cent of the lead, 95 per cent of the zinc, and 62 per cent of the copper recovered in the state. In past years the percentage production of copper from the Coeur d'Alene District has been even higher (90 per cent in 1950 and 87 per cent in 1951), but in 1952 this dominance was cut somewhat by significant production of copper from the Blackbird cobalt mine in Lemhi County.

**Geology**

Deposits containing lead, zinc, and copper separately or in combination and often including silver, gold and other minerals are widespread throughout the mountainous part of southern Idaho from Bear Lake on the east to the Silver City-South Mountain area on the Oregon border. They are also found in the mountains north of the Snake River Plain, where most of the current development is taking place.

Some of the ore is rich but none of the mines appear to have large enough ore-bodies to warrant large-scale development. Many are worked by a

small labor force intermittently and during the summers. The few permanent mines, principally the Triumph in Blaine County, the Clayton in Custer County, and the Blackbird in Lemhi County account for most of the production.

The topography has discouraged economic activity outside the long valleys, and no large development took place prior to the opening of the cobalt deposit. Geological surveys by government agencies and intensive surface prospecting by individuals have located many occurrences but few large deposits which can be operated profitably.

Transportation

Poor accessibility is the main hindrance to development of the many small deposits in central Idaho which do not have sufficient high-grade ore to cover the cost of building transportation facilities. Accessibility varies from the Triumph mine in the Warm Springs District, which is 6 1/2 miles from the Wood River Branch of the Union Pacific Railroad, to the Mountain King Mine in the Seaford District, 102 miles by highway and forest road from the railhead at Ketchum, and other prospects which can be reached only by trail. The deposits which are close to the railway have a very real advantage, though many properties which enjoy this advantage fail to produce for other reasons. It is significant that the Warm Springs District, which is astride the Wood River Branch of the Union Pacific, is the largest producer of silver, lead, and zinc in southern Idaho.

Developers of the remote deposits cannot afford to build initial transportation facilities and can operate only during the summer. These producers must truck concentrates or hand-picked ore to the nearest railroad for transportation to smelters, most of them located in Utah.

Cobalt at $2.60 a pound has been developed in an area as remote as that in which many of the lead, zinc, copper deposits occur, while lead at 10 cents a pound, zinc at 13.5 cents a pound, and copper at 29.6 cents a pound cannot be profitably recovered.

Other factors

Climate closes the small mines during most of the year. Labor and financing are difficult to obtain, as many of the small mines are not on a sound footing. Current base metal prices have done little to alleviate this. Lead, zinc, copper and the other metals recovered with them are one of the best examples of co-production in the state. Every base metal mine in the area produces at least two minerals and in many cases co-production makes the operation profitable, especially where gold or silver are produced with the low-priced lead and zinc.

Present status and future possibilities

The present relatively small production of lead, zinc, and copper in southern Idaho will continue and may increase as transportation facilities improve. However, it is not expected that the area will ever become a major producer and the mineral deposits alone are not yet sufficient reason for building roads into the area.
Fluorspar

Fluorspar is the commercial name for the mineral fluorite, which is the principal source of calcium fluoride. Fluorspar is marketed in grades on the basis of the calcium fluoride content; acid grade containing at least 98 per cent, ceramic grade containing 95 to 98 per cent, and metallurgical grade less than 95 per cent, although these specifications may not be rigidly adhered to when supplies are scarce (U. S. Tariff Commission, 1952, p. 3). Idaho deposits were discovered during the early years of World War II and were developed but did not produce any significant amounts. The J. R. Simplot Company took a lease on the main property at Meyers Cove and began shipping acid grade fluorspar in August, 1951. The mine was operated through most of 1952 and until the mill burned down in April, 1953. It was announced in November, 1953 that the lease on the property had been dropped. Other prospects in the state are potential sources, but none was approaching production in 1953.

Idaho production in 1951 was 9,408 tons and in 1952 about 7,500 tons. The 1951 production for the United States was 347,024 tons.

Geology

Idaho fluorspar occurs as vein fillings in Tertiary volcanics. Because of silification, the veins are more resistant than the enclosing rocks and stand out as ledges. (Anderson, 1943b, p. 1). In spite of this they were overlooked for many years, partly because the commercial value of the mineral was not well known in the west. The deposits are in the relatively inaccessible Meyers Cove area, about 38 air miles southwest of Salmon. The veins of fluorite are numerous and outcrop at various levels on the side of a steep gulch through a vertical range of some 1,500 feet. The various veins must be mined separately, adding to the mining cost. The general geology of the area makes development expensive, particularly as mining is the only economic activity to pay for development.

Transportation

The fluorite area is not served by rail and cannot be reached economically by a railroad. Hauling must go 106 miles over forest, county, and state roads to Mackay, Idaho. Development was aided by the fact that it is in the same area as the Blackbird cobalt mine. The government helped build a road to the cobalt mine from Challis and part of it was also used in hauling fluorspar. Nevertheless, trucking was still expensive. Trucks carried 6-10 tons to Mackay at a rate of $7.30 per ton or about 7 cents per ton-mile. At Mackay the government purchased the acid-grade fluorspar for about $60 a ton. Thus transportation to the railroad cost more than 10 per cent of normal market value. To this was added the cost of bringing equipment and supplies to the mine. The fact that the chief product was the relatively high value acid-grade helped to mitigate the high transportation costs.

To keep costs at a minimum, milling and beneficitation was done at the mine rather than at the railroad or at some more central location.
Market

The market for acid-grade fluorspar in the west is chiefly the aluminum industry, which uses it to produce artificial cryolite and aluminum fluoride. It also is used to make carbon fluoride, important in the separation of uranium 235 from uranium metals. The wartime expansion of the aluminum and steel industries in the area has led to the development of several western deposits.

Because of these uses, both acid and metallurgical grade fluorspar are classed as strategic minerals and are being stockpiled. The Idaho deposits which were developed with government assistance, had a government market and production is presumed to have gone into the government stockpile.

Government

Government fluorspar policy is almost all on the assistance side of the ledger. The federal government contributed 50 per cent of the cost of some of the exploration work under the Defense Minerals Emergency Act; it assured a market at a fixed price under D.M.E.A.; roads built to the cobalt deposit with federal aid indirectly helped in the development; and the Idaho Bureau of Mines and Geology sent parties into the area during the summer of 1945, 1952 and 1953 to do topographic and geologic mapping. In addition tests were run in the laboratories of the Idaho Bureau of Mines and Geology to develop milling flow sheets for beneficiating the deposits. (Prater, 1943).

Other factors

The climate makes fluorspar mining difficult. Deposits are in an area of heavy snow and the roads are difficult to keep open. With the spring thaw, roads become impassable to heavy vehicles, and as the thaw takes place at different times at different altitudes, the shipping season is seriously curtailed.

Labor presents special problems. The fluorspar operation was not on a large enough scale to warrant construction of normal town facilities. The labor staff of miners, mill-workers, and truckers averaged about 40 men. Living facilities for men were constructed but few family facilities. The attraction of the area's hunting and fishing helped the labor situation somewhat during the open months.

It was hoped that the development stimulated by government aid would be sufficiently stable to continue in operation and supply acid-grade fluorspar to the aluminum industry of the northwest and metallurgical-grade fluorspar to the steel plants in Utah. However, in the autumn of 1951 a remarkable deposit of fluorspar was discovered in Ravalli County, Montana, some 20 miles north of the Idaho border. Several lenses of massive fluorspar, the largest exposed over an area of 180 by 240 feet and of unknown thickness were found. (Taber, 1952, p. 4). These deposits are equal in grade to the Idaho deposits, but are much more easily mined and are located some 25 miles from the Northern Pacific Railway at Darby, Montana. The presence of these low-cost deposits no doubt played a major part in the decision not to rebuild the mill at Meyers Cove.

The fluorspar claims were leased and a royalty had to be paid to the original claim holder. The Meyers Cove claims now revert to their original owner,
who is free to work them, taking advantage of the development work by Simplot, or to lease them to some other operator.

New deposits have recently been discovered near Challis which are better located than those in the Meyers Cove area and which may stand a better chance of successful development.

Barite

Barite is a nonmetallic mineral which has enjoyed limited production in southern Idaho during the last few years. A unique combination of factors made possible economic recovery from deposits which have been known since the early years of the century (Ross, 1941, p. 151). The mineral barite in its pure form is barium sulfate. It occurs widely throughout the world as veins, usually in limestone or dolomite, or as residual deposits. The qualities which give barite value are its high specific gravity (4.5) and its chemical inertness.

Geology

The chief Idaho barite deposits are replacement bodies in the Pennsylvanian Wood River limestone. They are in the Wood River Mountains about 18 miles northwest of Hailey, which is in one of the long valleys penetrating central Idaho. The deposits occur close to the top of a mountain at about 7,000 feet and are very difficult to reach. Since the deposits are exposed and are mined by quarrying, development is relatively simple.

Unbeneficiated Idaho barite is suitable for use in well-drilling muds. Chemical and paint uses require 95 per cent BaSO₄ while the Idaho deposits average about 90 per cent.

Transportation

The Wood River branch of the Union Pacific railroad runs north through the valley of the Big Wood River about 12 miles by road from the barite deposits. The main transportation problem is in moving the rock from the mountain to the railroad, and trucks haul on contract over a tortuous road which rises more than 1,500 feet in about four miles. The cost is more than 10 cents per ton-mile.

Markets

Since the chief market for Idaho barites is as a well-drilling mud, the price is set by the large producing areas of Arkansas and Missouri. Idaho deposits do not compare with these in size nor can they compete with them in the major market areas. However, the high weight of barite, coupled with its low value (1950 average for ground barite for well-drilling use was $18.85 per short ton) makes it an expensive commodity to transport, so the Idaho deposits have a natural market in the adjacent oil producing areas of Wyoming, Utah, and Montana.

Processing and marketing have been handled to keep costs to a minimum. The only producing deposit is leased by the J. R. Simplot Company from the Bunker Hill and Sullivan Company, which owns the claims. The rock is trucked to the railroad on contract, then shipped to the Simplot fertilizer plant in Pocatello, where it can be ground, sized and bagged using equipment which is also used in processing fertilizer. An extensive investment in plant and equipment has not been required.
Although some barite is marketed under the Simplot name, the company has a marketing agreement with two of the principal southeastern producers under which it puts barite in their bags and fills their orders in the west. Since the product is the same, the market is satisfied, and both companies are able to profit through avoiding part of the transportation cost. Simplot also avoids selling costs.

It may be possible to upgrade Idaho barite to 95 per cent and sell it on the paint and chemical market, and some consideration is being given to this.

Other factors

The climate limits the mining season to four months, and some time must be spent each spring getting the road into usable shape.

Other nearby lower grade deposits of barite are currently under investigation to see whether beneficiation can upgrade them. It appeared doubtful in 1953 whether large scale development of the deposits would be profitable, as it would involve setting up a more elaborate plant and marketing system, which the known size of the deposits could not support.

Pumice

Western pumice is mainly used as an aggregate in concrete and concrete blocks, competing with sand and gravel or cinders. Because of its light weight and excellent insulating properties, pumice is marketed over a wider area than most aggregates. Nevertheless, it is a low-value, bulky material that cannot withstand transportation costs which are high relative to its value.

Idaho ranked among the first four pumice producing states each year between 1946 and 1950 and produced more than 10 per cent of the national total.

Since the population in the Idaho market area is small, the production of pumice seems likely never to expand greatly unless new uses widen the market area.

Geology

Pumice is a porous, siliceous volcanic glass. It forms when molten lava, ejected from a volcano, cools quickly before contained steam and gases can escape. The bubbles caused by such gases make the resulting rock very light and frothy, so that it may float on water in spite of its specific gravity of about 2.5. Acid lavas are most apt to give rise to pumice formation, as their greater viscosity is more likely to plug the volcanic vent, with the resulting build-up of pressure and violent eruption.

Pumice deposits develop close to the site of volcanic activity as the material breaks down rapidly during transportation. The frothy rock is concentrated to some extent by air classification during settling, and further by wind action on the ground. Good deposits may develop when pumice falls on or is carried to a body of water, where it floats, becomes water-logged,
settles as a sedimentary deposit. Because of the susceptibility to physical break down through abrasion and attrition, most existent pumice deposits are of relatively recent age (Tertiary or Quaternary).

The southern Idaho deposits are associated with silicic flows of the Miocene or early Pliocene age, the major evidence of which has been buried by later Pliocene and Pleistocene basalt flows. One hypothesis, which is supported primarily by indirect evidence such as pumice deposition, indicates that there was a chain of volcanoes extending from the Yellowstone Park area along the axis of the Snake River plain towards Boise, and that most of the rhyolitic cones were buried by later basalt flows. Where pumice deposits occur at the edge of the plain, they are mapped as a part of the Pliocene Salt Lake formation. (Mansfield, 1952, p. 54).

Deposits are known to exist in the Magic Valley Reservoir area in Blaine County, on the Fort Hall Indian Reservation, and in the Idaho Falls area. No doubt other deposits are known to residents but are not worth attention at this time. Miocene pumiceous tuffs are recorded as being extensive in Cassia County (Anderson, 1931, p. 38), and the more consolidated pumiceous tuffs, which might be expected to accompany pumice deposits, are quarried as building stones in Cassia County and in the Lava Hot Springs area in Bannock County. Most of the known deposits are adjacent to the plain, and so there is no physical barrier to their exploitation.

Production in 1953 came from pits a few miles southeast of Idaho Falls, where the hills which border the Snake River Plain are underlain by large tonnages of pumice. This material, which can be traced for some miles, is a well sorted water-laid pure pumice. It overlies a welded rhyolite tuff in the only place where the base was observed, and is capped in places by a thin layer of welded tuff. In places the overlying cap has been worn off, and stream erosion has cut deep into the pumice. These gullies have been filled by a very fine wind blown, loess-like soil. Trenching of the hills east of the plain near Ammon has shown that in almost every case where the cap is not present pumice underlies the thin soil which has developed. Visible reserves are such that there has been no need to look beneath thick soil or cap rock.

The geology of the deposits is quite simple, and once deposits are outlined, mining is not difficult. Cuts show the pumice to be at least 75 feet thick. It is mined by cutting into the hills with bulldozers and power shovels. Overburden increases into the hills and mining is stopped when it becomes too thick to strip economically.

Transportation

Mine run pumice is currently valued at $2 a ton at the mine. Since it is low-value and is very light per unit of volume, transportation costs make up the major part of its cost in any area not adjacent to the mine. Those deposits which are being mined are very well located with respect to transportation, being within five miles of good rail facilities. The many deposits not so well located cannot be developed at this time because the cost of moving pumice to a rail line would be prohibitive. Present operators are building a new road to the deposits, eliminating hills to cut down on trucking costs.
There are two major producers of pumice in the Idaho Falls area: Clark Concrete Construction Corporation and Pumice Incorporated.

Clark mines pumice from its own pits for use in its block plant. Some 30,000 tons a year are trucked 9 miles from the mine to the plant in Idaho Falls, where the material is manufactured into pumice blocks which are marketed throughout southern Idaho and adjacent parts of Utah, Wyoming, and Montana. The company operates entirely by truck, as it finds that it can serve its area adequately and cheaply by this method. Though it is located on the railroad, the company has no rail spur, as shipping by rail involves trucking to a spur and loading, reversing the process at the market. Use of trucks limits the area of the market, but it is possible to ship the higher value blocks by truck where it might not be economical to ship raw pumice.

Pumice Incorporated produces some 50,000 tons a year for the open market. Production is trucked from the mine to a siding, a distance of less than five miles, where it is sized and loaded on rail cars which hold an average of 50 tons. All rail facilities were built for other purposes and are leased from the railroad. Pumice is shipped by rail to Idaho and adjacent states the largest market area being in northern Utah. Recently shipments have been made to North Dakota, Minnesota, and Michigan, and attempts are being made to expand this market. Although the cost of pumice may be increased several times by transportation charges, its desirable features give it a market, and Idaho is the closest source for a wide area.

One of the main competitors for the midwest market is New Mexico. In order to compete with the New Mexico deposits, Idaho producers requested an adjustment in freight rates from the Interstate Commerce Commission and were granted lower rates in certain areas effective August 1, 1953*. The new rate has reduced the cost of shipping car-load lots of pumice from sidings near Idaho Falls to Chicago from $12 per ton to $7.80. These reductions indicate that negotiated freight rates can be reconciled. Also, after the reduction of rates into specific areas by the I.C.C., the railroad has voluntarily adjusted other rates to bring them into line.

The Sunite Sales and Manufacturing Company was reported to be developing the deposits north of the Magic Valley Reservoir in Blaine County. The company had the contract to build 350 dwelling units in the new atomic city at Moab, Utah, and planned to use pumice in this construction (Hailey Times, Dec. 10, 1953). The deposits are about 10 miles southwest of Bellvue, which is 5 miles south of Hailey on the Wood River Branch of the Union Pacific. As in the case of other deposits in the state, reserves are abundant and the limitation on production was transportation costs.

Markets

Pumice, which previous to World War II was used principally as a natural silica abrasive, has undergone an increase in production of more than 800 per cent since 1944, and a complete change in market, so that today more than 90 per cent of production is used in building as a light-weight aggregate. However, pumice still supplies a very small part of the market for aggregate; some 672,000 tons were used in building in 1950 as opposed to almost 152,000,000 tons of sand and gravel. More than 90 per cent of Idaho pumice production is marketed within Idaho, Utah, Wyoming, and Montana.

As long as this is true, production will not be great as the market area is one of small population. The market area is being extended through lower freight rates but markets to the east are remote, and the west coast can be served by deposits in New Mexico and Oregon.

The Clark Corporation, with a primary interest in the pumice block market, is installing high pressure curing equipment which will produce blocks which do not shrink or crack - a defect in present day blocks. This new plant is expected to increase the use of pumice blocks for building.

Pumice Incorporated, with much broader market interests, has developed a series of products ranging from traction granules, to give cars traction on icy roads, to soil conditioners and various types of aggregates. Much hope is held for the pozzolan market. Pozzolan (sometimes spelled “pozzolana” or “puzzolana”) is defined by the American Society for Testing Materials as “a siliceous or alumino-silicate material which in itself possesses little or no cementitious value, but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.” Pozzolan is used extensively in dam construction where it adds strength and cuts down on permeability under high water pressures.

Pozzolan was used in the construction of Palisades dam on the Snake River east of Idaho Falls. The source was blast furnace slag from the Chicago area which is sold very cheaply, but on which railroad charges are $14 per ton. A similar pozzolan produced at Idaho Falls could be transported to the dam site for a fraction of this cost, and the local company could market in quantity for less than the transportation cost from the current source area. With the dam building programs of the west, a market for pozzolan appears assured, and as its special properties become recognized, its use should spread into other fields.

Other factors

The winter weather prevents mining for 2 to 4 months of the year, but imposes no serious hardships on the operators, as they are able to stockpile over that period. The dry climate prevents the pumice from taking on too much moisture and breaking down.

The main source of competition for pumice is from other aggregates, which must be combated through lower transportation rates or better marketing. Competition from other pumice deposits also limits the potential marketing area. Oregon and New Mexico contain large pumice deposits which can supply
the west coast more cheaply than Idaho. However, the Idaho deposits are well located to serve the large markets of the mid-west should freight rates allow them cheap access to the area.

Technological developments which may lead to better pumice blocks and new pumice products are the other main hope for the future.
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