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Geologic Considerations and Solid Mineral Potential of Alaska

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ABSTRACT

In marked contrast to Alaska's petroleum industry, production from the State's mining industry has declined drastically. Despite favorable geologic conditions, mineral exploration and development have been held back by inaccessibility, rugged terrain, severe climate, and scarcity and high cost of labor. Changing economic and political conditions, improved exploration techniques, and the ever increasing demand for minerals have again directed attention to Alaska's mineral potential. Important discoveries in British Columbia and Yukon Territory have further stimulated exploration in Alaska. The probability that significant discoveries will result is high.

The titaniferous iron ores of southeastern Alaska probably will be brought into production soon, but the greatest exploration effort is presently directed to the search for porphyry-copper-molybdenum deposits. Probability of success appears good. Minable lead-zinc deposits may be discovered. Beryllium-fluorite-tin deposits on the Seward Peninsula offer possibilities. Discovery of additional uranium deposits seems likely. Mercury exploration is active; small-scale production of platinum and antimony can be expected. No significant increase in gold mining is anticipated at present prices. Sharply increased production of barite and construction materials should result from developments in the oil fields. Alaska's mining industry may be approaching a period of considerable expansion.

Alaska's considerable reputation as a mineral-rich State dates back to the early gold rush days and to the discovery of the bonanza copper deposits of the Kennecott mine. Recent events have again focused attention on the potential wealth of the State's mineral resources. In 1968, the last year final figures are available, Alaska, with a mineral production valued at $221.7 million ranked 25th in the list of mineral-producing States. This production compares favorably with the values derived from its other natural resource industries in the same year — $5.5 million from agriculture, $217.5 million from fisheries, and $91.0 million from forest products. Preliminary figures show that in 1969 the State's mineral production increased to about $244.5 million. This value will increase dramatically as the vast petroleum resources of the Arctic Slope become available for use. Alaska will then become one of the country's leading mineral producing States.

These pleasant figures tend to disguise the unhappy fact that not all segments of Alaska's mineral industry have fared equally well. In 1969, 89 percent of Alaska's total mineral production, or $218.7 million[2] was derived from crude oil and natural gas in the Kenai Peninsula and the offshore Cook Inlet fields; $15.1 million came from the production of sand and gravel. The value of all other mineral products produced in the State, including bituminous coal, barite, gold, silver, mercury, copper, gemstones, platinum group minerals, and stone totaled only $10.7 million.

Mining, particularly metal mining, currently is at a very low level. In 1969, gold mining, once a leading industry in Alaska, yielded only $679 thousand. Mining of copper virtually ceased by 1933, and only small amounts have been produced since. It is a shocking fact that in 1969 there was not a single major lode mine in operation in Alaska. Coal production has declined, and production of industrial minerals continues to be relatively minor. Thus, on the basis of the value of minerals other than petroleum products, Alaska must be ranked very low in the list of mineral-producing States.

Do these gloomy facts mean that after a spectacular beginning and a few brief decades of relative prosperity Alaska's metallic mineral resources have become exhausted? Is its metal mining industry on its last legs? Perhaps, but I, for one, do not believe it. To the contrary, I think it is possible that metal mining in the State may be on the verge of a period of great expansion. Alaska is widely recognized geologically as a likely place to search for mineral deposits. Major geologic and physiographic belts can be traced northward from the conterminous United States through western Canada and westward into Alaska. These belts contain important mineral deposits in the western United States and Canada and may well enclose equally important deposits in Alaska. In Alaska we don't know as much about the geologic details within these belts as we would like. Only about 1 percent of Alaska has been mapped geologically in detail, 40 percent has been mapped at a scale of 1:250,000, 60 percent has not been mapped at all

[1] Publication authorized by the Director, U.S. Geological Survey.

[2] Figures from U.S. Bureau of Mines Minerals Yearbook

or has been mapped only in the roughest reconnaissance. Nevertheless, we do know enough to state with some confidence that there are in Alaska large relatively unexplored areas where the geology is favorable for the discovery of important mineral deposits. (See figure 1)

If this is true, why has not Alaska's mineral potential been more thoroughly utilized? The truth is that exploration and development of Alaska's metallic and non-metallic mineral resources have been retarded by many factors. Among these are inaccessibility; high transportation costs; the extreme ruggedness of much of the terrain; severe climatic conditions; the large areas that are covered by gravel, muskeg, or ice; and the scarcity and high cost of labor. All of these have combined to make mineral exploration in Alaska difficult and costly. Bringing a prospect into production once it is found is also expensive. Consequently, the search for minerals has not been pursued as vigorously in Alaska as it has elsewhere. With some exceptions, the mining industry has preferred to direct its search for new deposits to other areas, including many foreign countries, where conditions are less rigorous than in Alaska.

This situation is changing. I feel confident that important new deposits will continue to be found in the "Lower Forty-Eight" for a long time to come. Nevertheless, few geologist will question the statement that most of the undiscovered deposits in the conterminous United States are well hidden. They are going to be difficult and expensive to find, and many of them are going to be of lower grade than we have been accustomed to mine in the past. Thus, there is now more incentive to look to Alaska as a source of our minerals.

Added to this is the fact that with increasing nationalism throughout many areas of the world the friendlier and more stable political climate of Alaska is a powerful inducement to look to the North for mining investment.

An additional favorable factor is the increasing Japanese demand for minerals. According to the September 1969 issue of Engineering and Mining Journal, the Japanese market for British Columbia minerals is about $150 million a year and is expected to expand to $550 million a year. Mineral deposits in Alaska are geographically in a good position to share in this market. Finally, if the pipeline to bring oil from the Arctic Slope to Valdez is built, it will open up country that has been difficultly accessible.

For these reasons, Alaska is beginning to look more and more attractive as a field for mineral discovery. The availability of modern geophysical and geochemical exploration techniques and the widespread use of helicopter support in difficult terrain have increased immensely the effectiveness of exploration. Under these circumstances and with the ever-increasing demand for minerals by a metal-hungry world, prospects in Alaska that were of little interest only a few years ago now appear more and more attractive.

Further stimulation of interest in mineral exploration in Alaska has been created by important mineral discoveries in northern British Columbia and in Yukon Territory. At least 43 mines are in production in British Columbia and Yukon Territory, several more are in the development stage, and there are numerous active prospects. The rapid development of the mineral industry in this part of western Canada shows that exploration and mining can be done successfully in areas as remote and under climatic conditions as severe as in Alaska. It seems pertinent to review briefly some of the more significant developments that have taken place in western Canada in the last few years.

In recent years, mineral production in British Columbia has grown steadily, rising from a total of $186.3 million in 1960 to $422.8 million in 1969. (Figure 2) In constrast to Alaska, much of the increase has been in the production of metals, which rose from $131.7 million to $247.7 million in the same period, an increase of 116.0 million or 190 percent. Most of this can be attributed to the discovery of important copper or molybdenum mines at Highland Valley, Endako, and elsewhere.

Mineral production in Yukon Territory shows the same upward trend, though on a smaller scale. Output has increased almost 300 percent from $13.2 million in 1960 to $37.7 million in 1969 (Figure 3). Seven mines are in production in the Territory. Probably the two most important are Cyprus Mines' Anvil property near Ross River and Cassiar Asbestos Company's Clinton Creek mine. The Anvil mine began production in the fall of 1970. When operating at full capacity it will ship 1000 tons of concentrate a day to Skagway. Cassiars' Clinton Creek property began production in 1967. By the end of 1968 it had produced 60,000 tons of fiber, and plans were underway to boost its capacity to 80,000 tons per year. The mine is only 7 miles from the Alaskan boundary.

These developments have stimulated a wave of prospecting and exploration in Western Canada. The British Columbia Chamber of Mines estimates that during the next 5 years the mining industry will spend $670 million on exploration and development in British Columbia and Yukon Territory. Of this, $175 million, or $35 million a year will be spent on exploration; the remainder will be spent bringing into production properties that have already been discovered.

The pace of exploration has likewise quick-

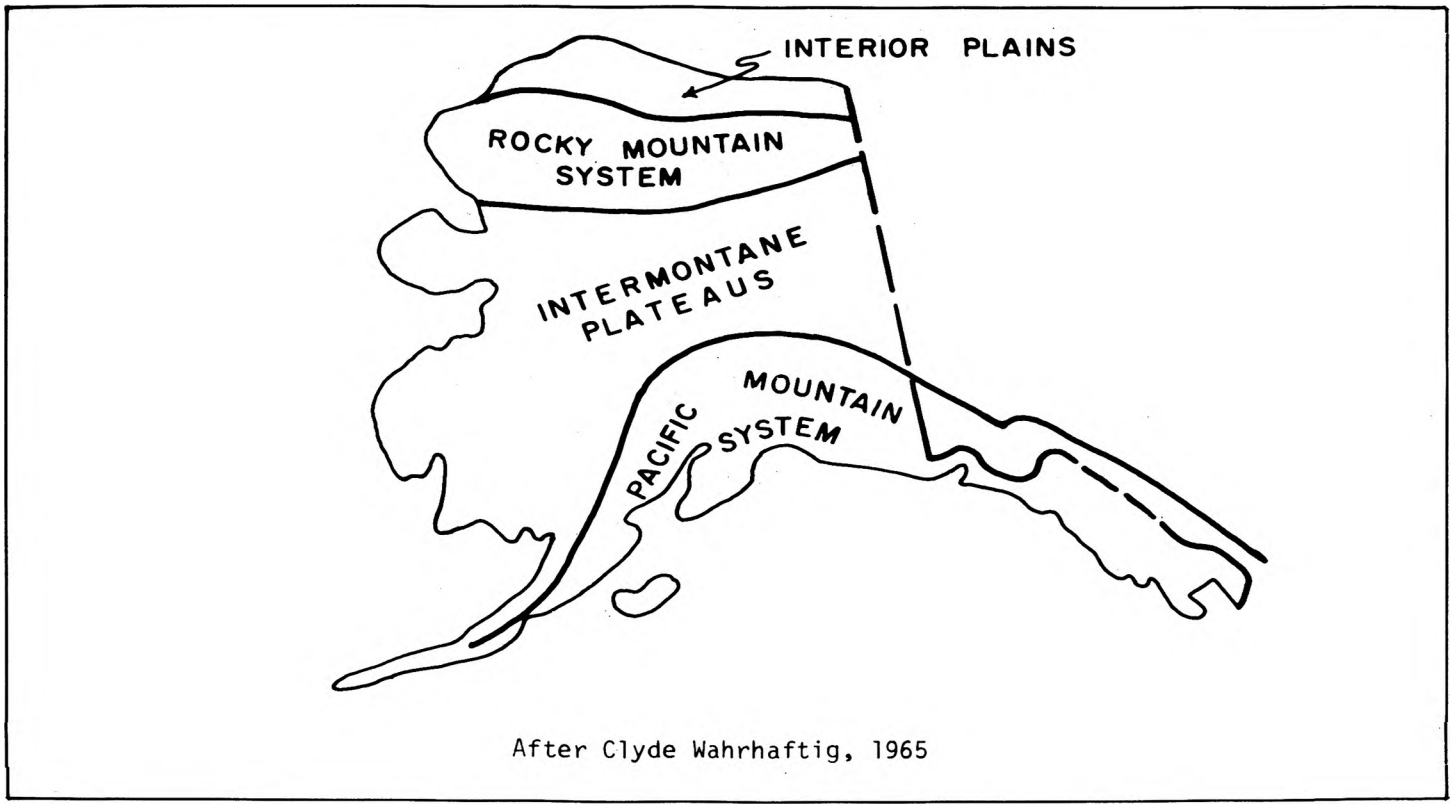

Figure 1. Major physiographic divisions in Alaska.

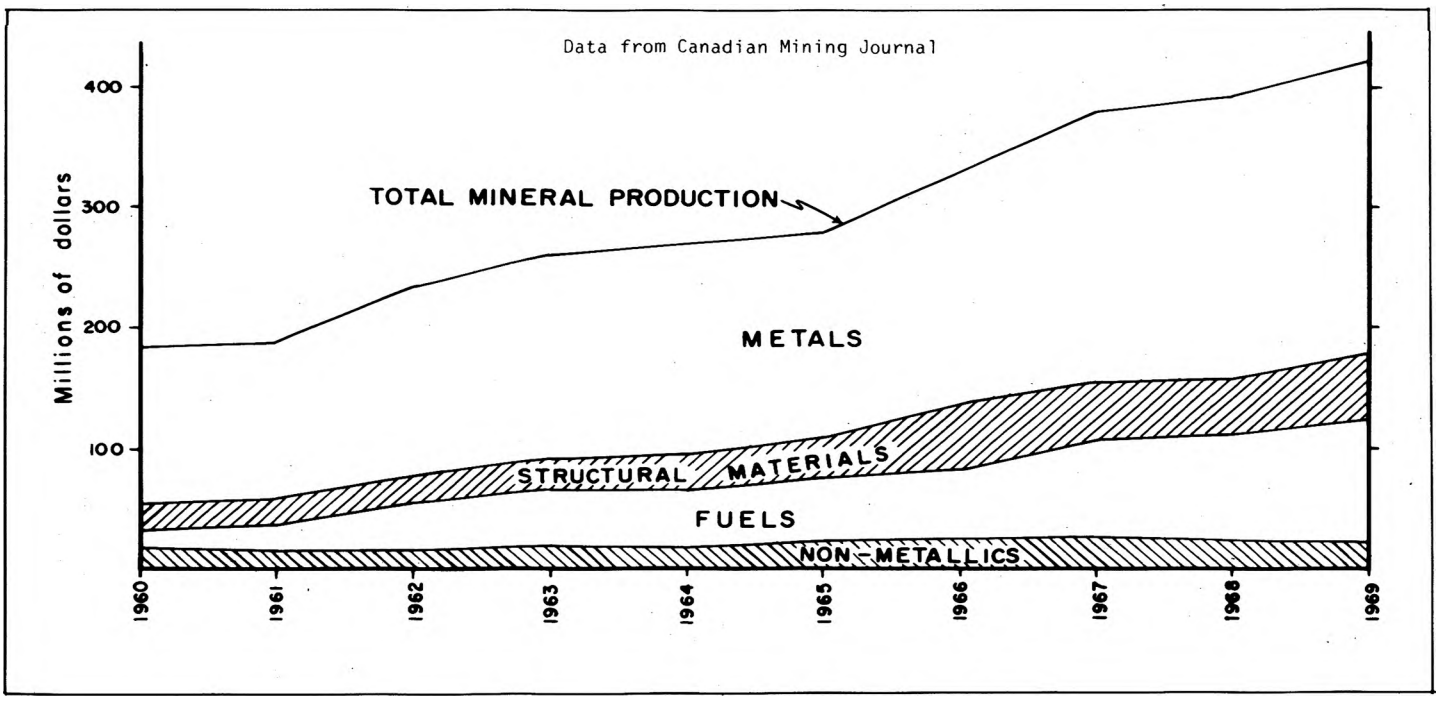

Figure 2. Value of mineral production in British Columbia, 1960-69

ened on the Alaskan side of the International Boundary. The Alaska State Division or Mines and Geology stated that in 1969 at least 13 major mining companies were actively exploring in Alaska, the greatest number in many years. The Division estimated that expenditures for solid minerals exploration amounted to as much as $6 million and are expected to increase. This is an encouraging increase over previous years but it still is a long way from matching expenditures in western Canada.

In this connection, a statement made by Paul C. Henshaw, then Vice-President of Exploration, Homestake Mining Company, seems pertinent. In a paper delivered in October 1969 at the American Mining Congress in San Francisco, he estimated that exploration costs in British Columbia and Yukon Territory were at the rate of $20 million to $30 million a year and that, on the average, two major deposits were being discovered a year. Thus, in western Canada it costs between $10 million and $15 million to discover a major deposit. Mine exploration in Alaska has not yet reached this level, but with the similarity of geologic and climatic conditions there is no reason to believe that exploration in Alaska will be any less costly than it is in western Canada — or any less rewarding. Given time and a continued exploration effort it seems certain that minable deposits will be found in Alaska, as they have in Canada. The future, therefore, seems hopeful.

What will Alaska's mining industry look like in the next 10 to 20 years? What minerals will be mined and where will they come from? Our crystal ball is cloudy on details, but I think that we know enough so that we can make some intelligent guesses. Let's briefly review what we know of some of the commodities that Alaska might produce and see what we can come up with.

Alaska's future mineral production must come largely from deposits that have yet to be found. But changing technologies may permit bringing into production resources that are already known but could not be exploited economically in the past. The high titanium iron ores of southeast Alaska provide an instructive example. Immense deposits of low-grade titaniferous magnetite have long been known at Port Snettisham, Klukwan, and elsewhere. The Klukwan deposits alone are estimated to contain several billion tons averaging 15 to 20 percent iron and 4 percent titania. Both the Port Snettisham and the Klukwan deposits are located near tidewater; they could be mined cheaply and the ore upgraded by magnetic methods but their high titanium content has made them unattractive to most users. However, a segment of the Japanese iron and steel industry is equipped to treat high titanium ores — and actually desires them. In November 1969 the Engineering and Mining Journal reported that discussions have taken place between the Marcona Company and Japanese steel makers with a view to bringing the Port Snettisham deposit into production. Development hinges on the negotiation of a satisfactory sales agreement. Should these negotiations be successful, E&MJ reports that production would

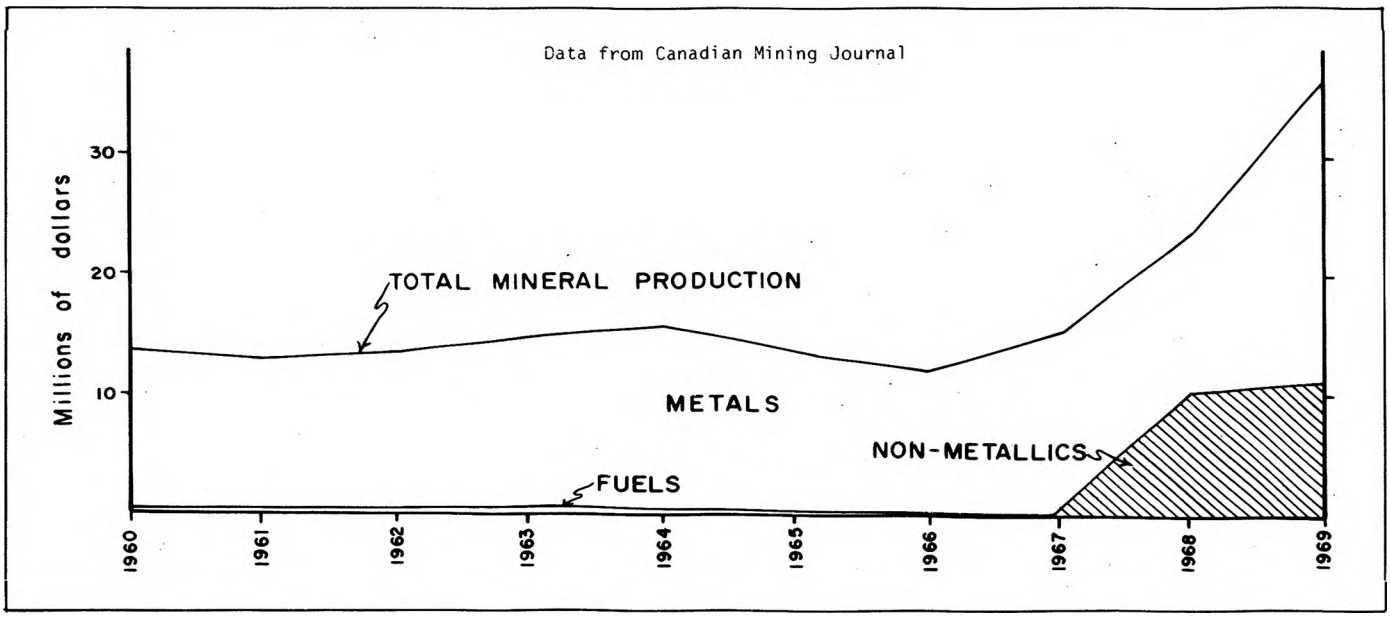

Figure 3. Value of mineral production in Yukon Territory, 1960-69.

be at the rate of 30 million tons of crude ore per annum. The Alaska Division of Mines and Geology reports that the U.S. Steel Company, which already has large holdings in the Klukwan area has negotiated a lease for additional acreage on the Klukwan Indian Reservation. It seems possible that one or both of these deposits may be brought into production in the not-too-distant future.

In the long run, the best opportunities for the revival of Alaska's solid minerals industry appear to be in the discovery and development of its copper resources. Copper deposits of several types are abundant in Alaska and the possibilities of finding and developing them seem excellent. Kennecott's Ruby Creek deposit in Brooks Range is an example. The deposit, which consists of chalcocite and bornite in a dolomitic reef breccia, has all the appearances of being capable of production, but is awaiting transportation facilities and the solution of some mining problems.

All of the State's former copper-producing districts are being re-examined and re-evaluated by the exploration companies. These include the Nizina district—the locale of the famed Kennecott mine, the Prince William Sound area—the site of the Latouche and Ellamar mines, and the magnetite-chalcopyrite skarn deposits of Prince of Wales Island. The Sumdum prospect, 50 miles south of Juneau, is being drilled by Humble Oil. Also receiving attention are the copper-nickel deposits associated with mafic or ultramafic rocks in the northern part of southeastern Alaska. These deposits have never been successfully worked, but exploration companies are taking another look.

Deposits in Glacier Bay National Monument, on Yacobi Island, and on Chichagof Island were investigated in the summer of 1969. Numerous bodies of mafic and ultramafic rocks with which this type of deposit is typically associated are known in Alaska. Few have been thoroughly prospected. It is highly probable that other occurrences of these rocks may be found in geologically unmapped parts of Alaska. Copper-nickel ore could be associated with some of them.

The biggest exploration effort in Alaska, however, is concentrated on the search for so-called porphyry-copper deposits. The successful development of important porphyry-copper deposits in British Columbia has aroused great interest in exploring the probable northern continuation in Alaska of the British Columbia porphyry-copper trend.

The best known of the Alaskan porphyry-copper prospects are the Orange Hill and Bond Creek properties near the head of the Nabesna River. Both are known to contain very large tonnages of copper-bearing rock. The grade is probably too low to mine under present conditions, although it compares favorably with that being mined at the Brenda deposit in British Columbia. It is reported that two well-known mining companies are planning additional drilling at Orange Hill. It is also reported that several companies have combined in a joint venture to drill a promising porphyry-copper prospect at Horsfeld on the northeast flank of the Wrangell Mountains.

There are numerous other places in Alaska where granitic intrusive rocks are known and where porphyry-type deposits are likely to occur. The Alaska Range is a promising place and is receiving much attention by exploration companies. Porphyry-copper-type deposits may also be found in the rugged and little explored Coast Range. Large areas of probable granitic terrane in the Wrangell Mountains have been little prospected. Other potential areas are in the Talkeetna Mountains, the eastern part of the Chugach Range, and possibly a few in the Yukon-Tanana Upland. Deposits in these areas may well be of higher grade than the Orange Hill deposit. It seems very probable that persistant exploration efforts will be rewarded with the discovery of minable porphyry-copper deposits in Alaska.

The porphyry-type deposits may contain appreciable molybdenum as a coproduct; in some of them, molybdenum may be the most valuable constituent. Occurrences of molybdenum are distributed profusely in southeastern Alaska but are also known in the Alaska Range and in the Wrangell Mountains. The deposit that probably has attracted the most attention is the Nunatak deposit near Muir Inlet in Glacier Bay National Monument. The molybdenum content is low but the deposit contains many tens of millions of tons of molybdenum-bearing rock. It has been investigated on several occasions by different mining companies. Testing by deep diamond drilling has been done during the past three or four years, but the results have not been announced.

With one exception, Alaska's small production of lead and zinc has been derived as a by-product from mining of other metals. A number of the known deposits contain rock of possible ore grade, but established tonnages are relatively small. However, some of the larger ones may offer some promise. Much of the area adjacent to the coast Range batholith in southeastern Alaska provides a favorable environment for lead and zinc deposits. Assuming a continuing future demand for zinc, it is not improbable that minable deposits of zinc and lead will be discovered in Alaska.

Alaska's entire production of uranium has come from the Ross-Adams deposit on Prince of Wales Island. Numerous other radioactive occurrences are known in Alaska. Now that a market

for uranium is again developing, additional discoveries seem probable.

During the Government-sponsored mercury program of the 1950's, Alaska was a substantial mercury producer, mostly from the Red Devil mine in the Kuskokwim area. The Red Devil is reported to have been reopened by Japanese interests, the Cinnabar Creek and White Mountain deposits are working, and prospecting is said to be active in the Kuskokwim area.

Practically all of the small United States production of tin has come from the placer and lode mines on the Seward Peninsula. However, the known deposits are small, and grade is low considering the remote location. Some recent prospecting is reported but the area must be considered a marginal producer of tin. More promising are the chrysoberyl deposits of the Seward Peninsula. These were first recognized a few years ago by Sainsbury of the U.S. Geological Survey and were the subject of a lively staking rush. There has been no attempt at production pending a brisker demand for beryllium and the solution of metallurgical problems, but the deposits constitute a valuable resource for the future. Fluorite associated with the deposits may also be recoverable.

Gold resources of Alaska are very large, particularly placer resources. It is estimated that as much placer gold remains as has been mined. Except for the Hog River placer and a few other small properties, no gold mines are presently in operation. No significant revival of gold mining can be anticipated unless there is a substantial increase in the price of gold.

Alaska in the past has produced small amounts of antimony, chromite, platinum, tungsten, and some other metals. Goodnews Bay is the major U.S. producer of primary platinum. Time does not permit me to discuss these deposits. Production of these commodities is likely to remain small.

In the nonmetallic field, some interesting developments are possible. Alaska is well supplied with deposits of limestone, many of them convenient to tidewater. With the increasing industrialization of the State, the time may come when a cement plant will be built.

Asbestos minerals have been found in widely scattered localities in Alaska but until recently none appeared to offer much promise. A recent discovery of cross-fiber chrysotile asbestos resulted from U.S. Geological Survey mapping in 1968 in the Eagle C-4 quadrangle. It may be of real interest. The deposit is about 55 miles west-northwest of Cassiar Asbestos Corporation's property at Clinton Creek, Yukon Territory. The potential of the occurrence is not known. Cassiar Asbestos is reported to have reached an agreement with the prospectors who staked the occurrence. However, under Public Law 4582, the land has been withdrawn from location for nonmetallic minerals until January 1, 1971. Until title to the property can be established, nothing can be done.

Alaska has large reserves of coal and has produced a substantial amount, most of it from Matanuska and Nenana fields. In 1967, production reached a peak of 940,000 tons valued at $7.3 million. Coal, however, faces severe competition from oil and gas. Tending to offset this is the possibility of building large thermal power plants close to the coal mines and distributing power through transmission lines. If these developments should materialize, the future of the coal industry will be more favorable.

In view of developments in the oil fields, construction activity in Alaska should increase, and an increased demand for sand and gravel can be expected. Alaskan petroleum activity likewise has created a local market for barite for use as drilling mud. The Castle Island barite deposit is currently in production. Increased activity in barite prospecting is likely for these and similar materials that will be used locally.

SUMMARY

To summarize, I believe that if mineral exploration in Alaska is pushed vigorously, important discoveries will follow. The greatest potential seems to be with respect to copper. I believe that some very significant discoveries will be made in the extension into Alaska of the copper belt now partly defined in British Columbia. If so, Alaska will take its place within the next 10 to 20 years as an important producer of this metal. Molybdenum also seems to have a good potential for production in view of its close association with the porphyry coppers. The next few years may also see the titaniferous magnetite deposits of southeastern Alaska come into production. Discovery of lead-zinc deposits is also a distinct possibility. Under existing circumstances the future of gold mining looks dim. In the nonmetallic field, important discoveries of asbestos are possible, and the establishment of a cement industry is possible. Coal faces an uncertain future because of increasing competition from petroleum products, but this may be offset by the construction of pit-mouth power plants. Production of sand and gravel, barite, and other commodities used in connection with the petroleum industry should increase. None of these developments will take place easily or overnight. Many natural difficulties must be overcome, and mining companies will have to conduct their operations in such a way that they will do minimum damage to the environment. Develop-

ment of Alaska's mineral industry will also be affected by worldwide economic events which neither Alaska nor the mineral industry can control. In my opinion, in time these difficulties will be overcome. Alaska's mineral resources are too valuable not to be utilized.

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A. E. Weissenborn was born in Port of Spain, Trinidad, British West Indies. He was educated in the public schools of Montclair, New Jersey, and at Lehigh University, Bethlehem, Pennsylvania.

From 1925 to 1943 he was employed by various mining and exploration companies in Arizona, Mexico, Panama, Newfoundland, and Chile. He joined the United States Geological Survey in 1943 at Rolla, Missouri, as Assistant Regional Geologist of the Central Region.

In 1946 he was transferred to Spokane, Washington, as Regional Geologist, Pacific Northwest Region. He has been in the Pacific Northwest ever since except for temporary assignments in Alaska, Liberia, Dahomey, Guyana, Saudi Arabia, and Turkey. From 1951 to 1958 he also served as Executive Officer, Defense Minerals Exploration Administration for the Northwest Region. For several years this included responsibility for DMEA activities in Alaska. His present title is Research Geologist.

Mr. Weissenborn has written extensively on the mineral resources of Washington, Montana, Idaho, and Oregon. In 1969, in cooperation with geologists of the U. S. Geological Survey's Branch of Alaskan Mineral Resources, he was responsible for compiling a report for the Alaska Power Administration on the resource potential of a large part of Alaska.

Mr. Weiseenborn is a Fellow of the Geological Society of America, and a Member of the Society of Economic Geologists, the American Institute of Mining and Metallurgical Engineers, the Geochemical Society, the Northwest Scientific Association, and several other scientific and technical societies.

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