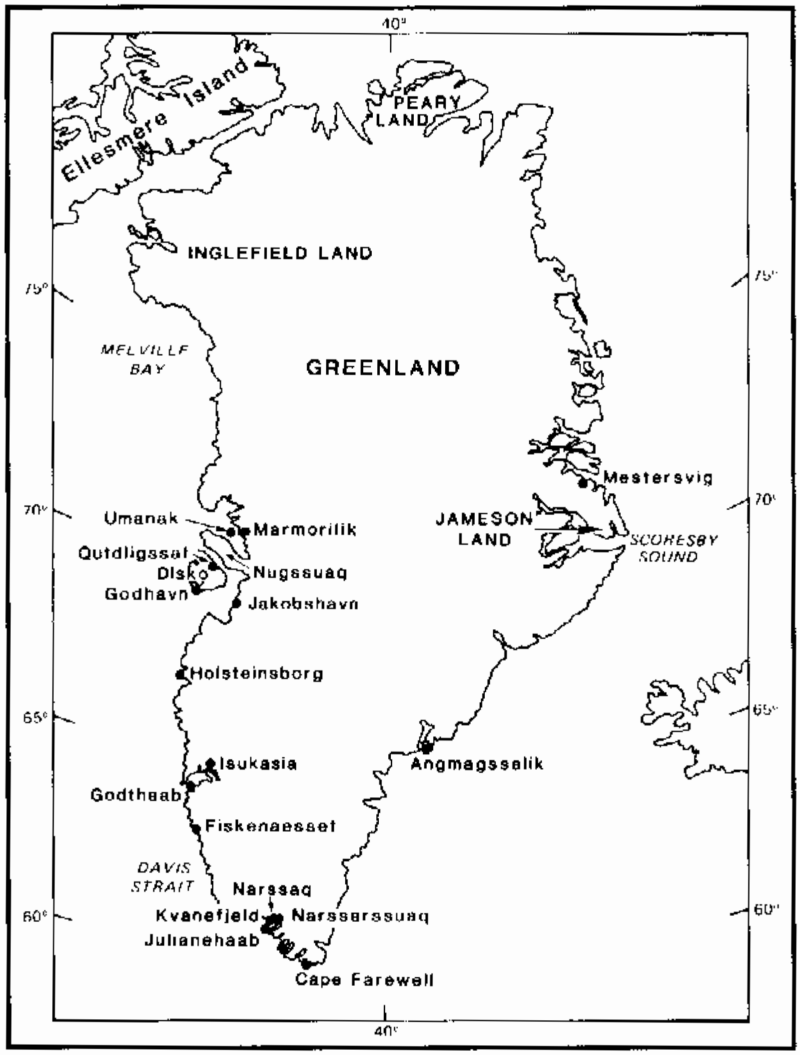
ENERGY AND MINERAL RESOURCES IN GREENLAND

by Jørgen Taagholt and H.C. Bach



Areas of mining and resource exploration in Greenland.

IN THE COURSE of the 15 or 20 years immediately following World War II, interest in the arctic region was mainly concerned with strategy and air traffic. Now there is additional interest in all arctic areas, including Greenland, as suppliers of energy and minerals. In order to protect the rights of Greenland residents with regard to nonliving resources, and in accordance with the Greenland Home Rule Act, the administration of mineral resources is a joint Denmark-Greenland responsibility, with the right of veto on either side.

MINING HISTORY

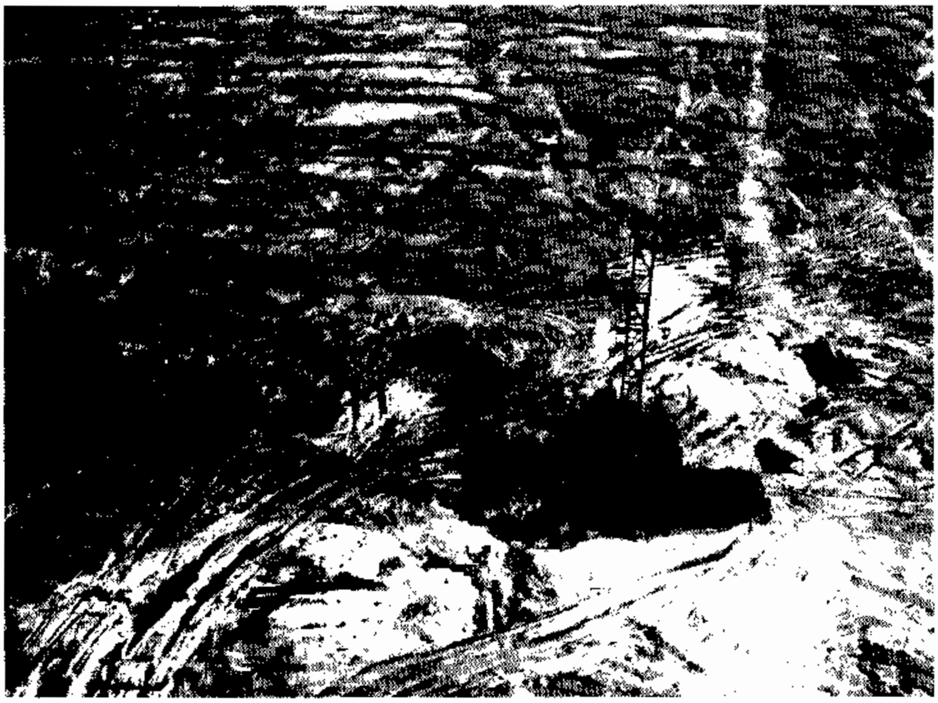
Up to the present century, mineral production has been scant in Greenland. The main products are cryolite, graphite, copper, and marble. Of these, the only significant contribution to Greenland's economy has been cryolite, which is a glassy, white fluoride of sodium and aluminum. During World War II—when Greenland's links with Denmark were severed—the export of cryolite to the United States and Canada provided a reliable basis for the island's economy. The production of aluminum, which uses cryolite as a catalyst, was greatly increased in the war years. The deposits of cryolite are now exhausted after a production of 3.5 million tons, and the export of cryolite has ended.

Between 1924 and 1972, 600,000 tons of coal were mined at Outdligssat on the island of Disko. The mining settlement was closed in 1972. Future coal mining in the Nugssuaq area will be discussed in a later section.

Lead and zinc are among the five metals in the world that are of greatest importance to industry, so these resources in Greenland have seen some exploitation. In the period 1956 to 1962, some 130,000 tons of concentrated ore were shipped from the lead mine at Mestersvig in east Greenland.

The lead and zinc mine at Marmorilik in the district of Umanak is the only mine that is still being worked. In 1971 the firm Greenex A/S obtained a concession to explore and exploit this area for the period up to 1996.

Jørgen Taagholt, *Danish Scientific Liaison Officer for Greenland, earned his M.Sc. in 1961 from the Technical University of Denmark in plasma physics. He served from 1969 to 1983 as head of the Ionosphere Laboratory and since 1967 has been the scientific adviser to the Danish government on research in the Arctic.* **H. C. Bach** *graduated as Royal Danish Navy Officer in 1958 and served the Commander of the Standing Naval Forces of NATO in the North Atlantic. He also served at the Danish Defense Command's Long Term Planning Section, and at the NATO Headquarters in Brussels.*



About 80 percent of Greenland is covered by ice, and below the ice is a mountainous terrain. The topography of the bedrock has been mapped based on measurements by Danish-built 60-MHz radar equipment. The photo shows a unique method of exploratory drilling in the Umanak district, in search of minerals in the rocks below the ice. (Photo by J. Taagholt.)

During the first 3 years of production (1974-76), prices on the world market were fairly high, and the company made a profit of about $12 million per year. Zinc prices then slumped dramatically, thus reducing profits. Beginning in the spring of 1979, prices rose again and there were several good years. During 1985, however, zinc prices again dropped dramatically.

The mine produces around 650,000 tons of ore per annum with a yield of about 140,000 tons of zinc concentrate, 40,000 tons of lead concentrate, and 35 grams of silver per ton of ore. The mine employs some 320 people, 150 of whom are Greenlanders.

Environmental Effects

The Danish government and Greenex A/S have made a comprehensive study of the effects on the environment around the fjord communities involved in mining. This has resulted in a dramatic reduction of disturbance to the environment. At present an effective relations committee exists between the mining company and the district of Umanak.

Furthermore, it has been established that the mining activities do not endanger the health of the population, and clear agreements for shipping methods have been reached to ensure that the traditional winter hunting near the fjords is in no way disrupted.

RAW MATERIALS AND ENERGY RESOURCE DEVELOPMENT

At Isukasia near the bottom of the fjord complex at the edge of the ice cap some 150 km northeast of Godthaab—there are deposits of iron ore. The purity of this ore is just over 30 percent, which is low, but about 550 million tons have been traced, and the expectation is something approaching 2 billion tons. If iron mining activities are to be established, hydroelectric energy will be needed, as well as a harbor and transport facilities, and these developments take time and investments.

Chromium has been found at Fiskenaesset in southwest Greenland. The company that holds the concessions to explore is investigating the possibility of exploitation, but the deposits are fairly sparse and the chemical composition of the ore is unfavorable.

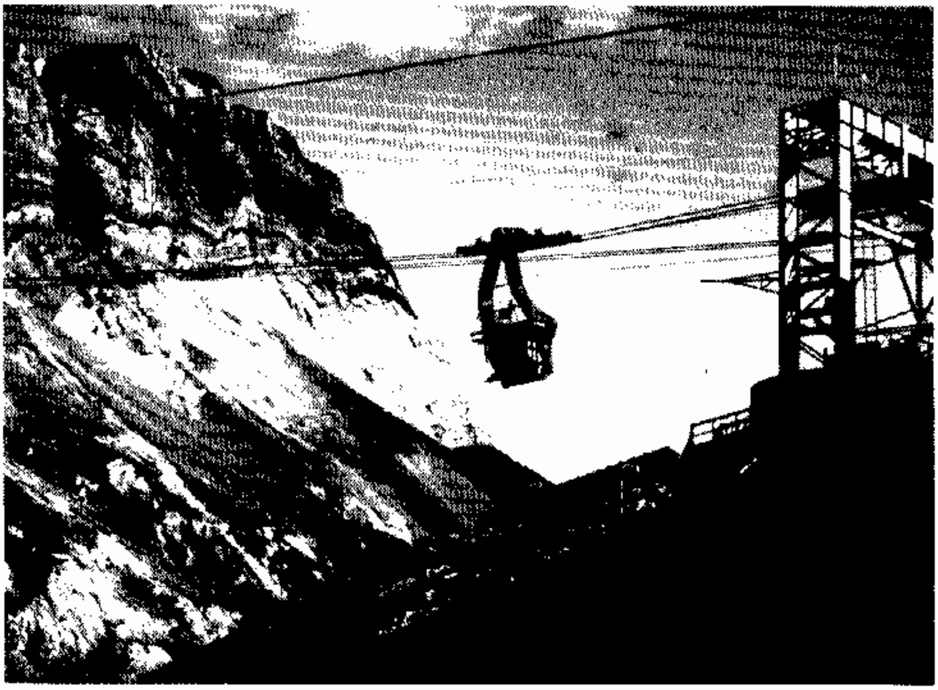
At Malmbjerget just south of Mesters vig, large deposits of molybdenum have been found. The purity is not impressive—about 0.25 percent—and the molybdenum lies between two glaciers and would be difficult to mine.

While searching for molybdenum in the concession area in northeast Greenland, Nordisk Mineselskab A/S discovered

More than 3.5 million tons of cryolite have been exported from the mine in Ivigtut; today, the deposits are exhausted. (Photo by J. Taagholt.)

silver and other precious metals. The greatest interest has, however, been aroused by a deposit of scheelite, which contains tungsten. Tungsten is used in steel production, and for other industrial purposes such as the manufacture of filaments in light bulbs and in radio tubes. As the price of tungsten is very high and the deposits look promising, production may begin in the next few years. Air transport would be the most likely method used for moving the scheelite out of the area.

Several of the known deposits of exploitable minerals are too small to develop for international industry. These mineral deposits (copper, nickel, platinum, molybdenum, chromium, thorium, fluorine, zirconium, lead, niobium, and iron) could, however, be mined on a small scale. Although Greenland has no history of small-scale mining by families, possibilities exist for such ventures. Small-scale mining would make use of rather primitive equipment and would require little monetary investment; it would also allow much more mobility than does large-scale mining. Methods of extracting these resources need further investigation—in cooperation with experts who have the practical experience.



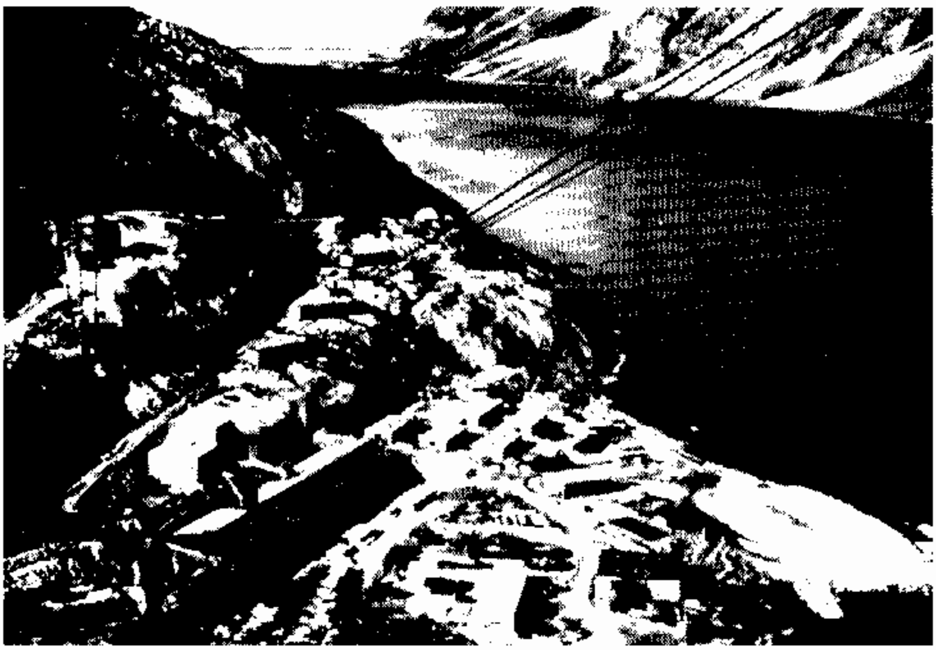
Transport of ore from the lead and zinc mine to the processing and shipping area at Marmorilik. (Photo by J. Taagholt.)

Uranium

The uranium deposit at Narssaq is the only deposit that has been investigated with a view to exploitation. Prospecting for uranium is being carried out in various other places in southeast Greenland, in part financed by the European Economic Community. Several deposits have been found, but their extent has not yet been charted.

The Narssaq uranium deposit has been determined to be 27,000 tons plus a reserve of some 16,000 tons. Production costs are expected to be fairly high, since the purity is relatively low (300 to 500 grams of uranium per ton of ore), and because the uranium is chemically linked to the minerals in the ore in a way that makes it difficult to extract. Mining ended at Kvanefjeld in 1980, after 20,000 tons of ore had been extracted; 4,000 tons of this amount was taken to the National Laboratory at Risø where the cost of extraction has been evaluated. For production to occur in Greenland, a sales price of about $50 per ounce is necessary. The decreasing world market price of uranium does not encourage further development at present.

In addition to the economic considerations of mining the uranium, policies concerning energy and environmental factors play a major role. The question of whether to introduce nuclear power in Denmark is also of importance. Demands are being voiced in Greenland for exploiting alternative raw materials and resource deposits found in Greenland. An objective view of the various options is desirable before a final decision to mine uranium is made. Extensive research into the environment



The production facility at Marmorilik seen from the entrance to the mine 700 m above the fjord. (Photo by J. Taagholt.)

has been initiated in the whole of the Narssaq area in order to provide a survey of the natural environment before production would begin.

Coal

With regard to coal production, attention is concentrated on the Nugssuaq peninsula, which has been estimated to contain 100 million tons of coal. Traditional methods of mining, however, would fetch out only about 20 million tons. The geology of an area approximately 325 square kilometers has been surveyed with a view to establishing the quantity and quality of the deposits, and more especially the energy value of the coal.

Some interest in these investigations has been shown by Danish power stations. However, on the basis of present information as to the thickness, location, and quality of the seams, they have not judged it to be technically and economically viable to exploit the coal, and have therefore not thought it reasonable to take part in the investigations.

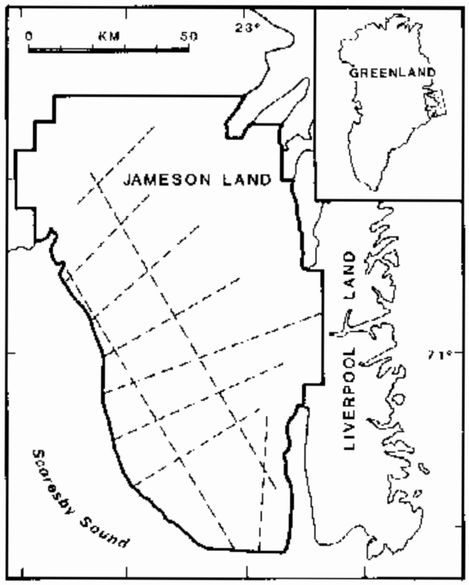
Greenlanders attach great importance to these investigations for prospects of employment and energy resources. Since Denmark is among the biggest importers of coal in the world, production of coal in Greenland would be of great significance if large recoverable deposits can be located.

Oil and Natural Gas

An oil survey was made on the continental shelf off west Greenland in the late 1970s. Five drillings were carried out in the area between 63° and 68°N, and all showed negative results. Thus, present information about this and other areas on the west continental shelf does not encourage further exploration.

In north Greenland, a sedimentary basin stretches from Peary Land in the east via Inglefield Land to the Canadian Archipelago, including Ellesmere Island, Sverdrup Basin, and Melville Island in the west. The expectation of finding oil and natural gas in this area is high. In the Canadian portion to the west, large gas reserves have already been found near Melville Island and Ellef Ringnes Island and oil has been found at Bathurst Island and Ellesmere Island near Eureka, a distance of only 300 to 400 km from Inglefield Land in Greenland.

Jameson Land presents the most interesting geological factors in the east Greenland area today with regard to oil. Nordisk Mineselskab A/S held a concession covering the period from 1952 to 2002 for exploring and exploiting all metals, coal, oil, and natural gas resources in an area covering 117,000 square kilometers between 70° and 74°N in east Greenland. The concession has now been transferred to a consortium called A/S ARCO Greenland (Petroleum Exploration and Production, Copenhagen) made up of the Atlantic Richfield Company; the Arctic Minekompagni A/S, Copenhagen; and a public corporation owned half by the Danish government and half by the Greenland Home Rule Authorities. The share capital of the latter public corporation will be $2.5 million.



Jameson Land concession area, with location shown on inset map of Greenland. Sites for seismic exploration are indicated by the broken lines.

The map shows the concession area in east Greenland corresponding to the Jameson Land concession signed in December 1984, running from January 1, 1985, and covering 6- and 12-year periods. The concession includes some 10,000 square kilometers; between 1985 and 1990, the consortium is obliged to conduct an 800 km seismic profile indicated by broken lines on the map. It will also drill two holes down to 60 meters below the Upper Permian layer limited to a maximum of 3,660 meters. During the period following 1990, another 500-km seismic profile and 9 drillings will be made.

Geothermal Energy

Geothermal energy plays a part in many communities in the far north Atlantic. This ranges from warm springs, rather poor in energy in Greenland, that maintain water supplies throughout the year in small communities such as the ones around Scoresby Sound and on the island of Disko, to a greater exploitation in Iceland where hot springs ensure reliable and cheap heating and form the basis for extensive market gardening. Geothermal energy is, however, of only slight significance industrially, because the areas that are rich in this type of energy are geologically young and rather unstable, a fact that does not tend to encourage massive investment in industrial plants.

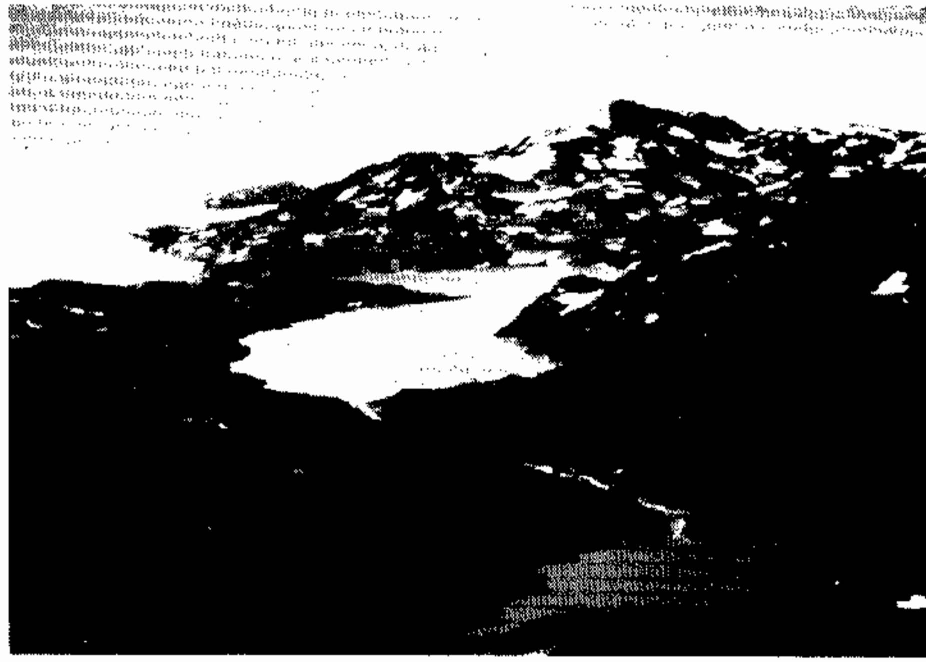
Hydroelectric Power

For many years it has been appreciated that hydroelectric power stations in Greenland were a possibility. Because there are no local demands for large amounts of energy in Greenland, there has been no incentive to invest in hydroelectric power stations.

Since the energy crisis in 1973, interest in making use of the arctic water reserves has arisen, and the Ministry for Greenland has in recent years received various propositions from several Danish and foreign companies.

In recent years comprehensive glaciological, geological, and meteorological investigations have taken place under management of the Danish Government, in order to map out the technical and physical possibilities of setting up hydroelectric plants. Drafts have been made of 16 power stations in the area between Cape Farewell and the Nugssuaq Peninsula. Particular interest centers in the extensive basin areas off the settlements that can be reached by sea, where the power stations might provide energy for such things as mining and the production of fertilizers or aluminum. Also of interest are the basins close to settlements that might be used for local energy supplies.

Preliminary calculations in connection with forming an energy plan for Greenland up to the year 2000 show that over the next 15 years savings in energy cost for Greenland may amount to a million dollars, if oil and coal are replaced by hydroelectric power. On the other hand, the cost of setting up the plant would correspond roughly to the savings. If, however, such a change were to be made, calculations show that after the initial period of the changeover, Greenland society would be able to achieve an annual savings on the energy budget in about the year 2000 of some $50 million, even if the



Nordbosø in Johan Dahl Land about 25 km north of Narssarssuaq is being explored for hydroelectric power possibilities. The lake, which is situated at 660 m above sea level, drains a precipitation area of 150 km^2 and a melting area of the ice cap covering 35 km^2. The annual volume of water leaving the lake is presumed to be able to form the basis for a production of energy totaling some 225 million kilowatt-hours per year, corresponding to twice the present consumption of electricity in Greenland. (Photo by J. Taagholt.)

price of coal and oil were to rise only moderately (about 2.5 percent per year).

Industrial exploitation of hydroelectric reserves in Greenland would require investment on a very large scale in plant and distribution systems and in the actual consumer industries.

One of the large basins included in the survey is situated in Johan Dahl Land north of Narssarssuaq. If a power station were to be positioned here, it would be able to deliver energy to Narssarssuaq, Narssaq, and Julianehaab and to uranium production at Kvanefjeld or to any future industrial activities in the district.

The hydroelectric resources that have so far been pinpointed, and that are expected to be viable, would have a total production capacity corresponding to about half of the present output of electricity in Denmark. Hydroelectric investigations are still at the preliminary stage, but perspectives are wide. ♦

Back of the Book

• Noted

We are pleased to report the appearance on the UAF campus of the **Institute of Northern Engineering**. The new institute brings the Transportation Center, the former Institute of Water Resources, and the Engineering Experiment Station under one more cohesive (and conspicuous, fortunately) administrative umbrella. Dr. Tom Roberts is director of the Institute of Northern Engineering.

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Declining federal assistance will mean that Montana and Idaho will show smaller construction volumes this coming summer, but Washington and Oregon will be engaged in healthy public works construction projects. Thus predicts the *Pacific Builder & Engineer*, a Seattle-based magazine devoted to the interests of the northwestern United States' heavy construction industry. *PB&E* credits the coastal states' stronger building programs to their competition with California for foreign investments and their planning ahead for funding. In Oregon, this has been done by setting aside $23 million in state lottery income for biennial public works expenditures.

PB&E also noted that developers are eager to get new commercial and industrial projects underway in the Seattle and Portland metropolitan areas because these "are less overbuilt than other parts of the country." Although "less overbuilt" sounds less than enthusiastic, Alaska firms that are dismayed by what falling oil prices are doing to the state's capital project plans might cast their eyes southward for the '86 season.

• Meetings

This year, the **Arctic Science Conference**, also known as the 37th Alaska Science Conference, is going temperate: the meeting will be held the week of 8-13 June on the campus of the University of British Columbia in Vancouver. The location reflects not cabin fever but a search for better links with the Pacific Division of the American Association for the Advancement of Science, cosponsors of this conference with the Arctic Division. The Western Society of Soil Science, Arctic Institute of North America, Botanical Society of America (Pacific Region), Ecological Society of America (Western Section), Pacific Coast Entomological Society, and local chapters of the American Meteorological Society will meet with the Pacific and Arctic Divisions, holding their own technical sessions and cosponsoring others. Apparently engineering fields will not receive heavy attention, but with such sessions as "Geological Hazards Along the Plate Boundary: SE Alaska, British Columbia, Washington and Oregon," "Integrating Remote Sensing Information into Resource Management," and "Long Term Management of High Level Radioactive Waste Disposal," a person with applied-science interests could easily find enough useful information to justify attending the conference. (For those who feel no need to justify their presence at an Arctic Science