Bermuda grass takes hold on newly reclaimed land in lignite fields in East Texas.

sulfur and ash content, but also contains trace metals. These include uranium and the prospect of uranium and its fission products appearing in the stack gas of power plants raises health questions for the future.

The size of the Texas lignite reserves is obviously a highly relevant question. The state is fortunate in having a clearer idea of the extent and quality of its lignite reserves than do its neighbors who share the belt of Gulf States lignite stretching across sections of Louisiana, Arkansas, Mississippi, and Alabama. The mapping work done originally by the state's geologic survey has been carried on in recent years by the University of Texas department of economic geology.

Current estimates put Texas lignite reserves at 10 billion tons within 200 feet of the surface—200 feet is regarded as the practical maximum depth for surface mining. The whole 10 billion tons, however, is not economically recoverable by current methods. Estimates of that portion vary between 2.5 billion to 8 billion tons. The ratio of size of seam to depth is the main consideration.

As for the far larger reserves of deep-basin lignite, estimated at over 100 billion tons, there is already active interest in using it through in situ gasification. Air quality considerations make the process of burning the lignite underground and then piping the resulting gas to customers increasingly attractive. Texas Utilities has again taken the initiative. The company negotiated with the Soviets for use of their in situ gasification process and 2 years ago signed an agreement with the Soviet technology export agency, V/O Lincenstorg, to become the sole American licensee for the process. TU is continuing preliminary work on in situ gasification and plans to build a pilot plant on its lignite fields. It is also increasing its deep-basin lignite holdings.

As for nuclear power, which is being relied on in many other areas, not a single nuclear plant is in operation in Texas. Several nuclear plants in the planning stage were postponed in the early 1970's because of escalating costs. Now interest has picked up again. The state's first nuclear plant, located in Matagordo County in South Texas, is scheduled to come on-line in 1980. By 1985 nuclear plants should be in operation at three locations with capacity to supply 7200 Mw of power, about a quarter of the generating capacity planned for lignite and coal plants by then.

Lignite and Western coal can reasonably be counted on as a substitute for a significant portion of the gas and oil now used for generating electricity. It is less clear that other industries will be as successful in converting to coal. The major concern for the future lies in what many see as a contradiction between laws mandating increased utilization of coal and requirements against reducing air quality standards.

The issue is an acute one in Texas. The petrochemical industry, the state's economic bellwether, is a major source of pollution. It is also concentrated along the Gulf Coast so that replacement of natural gas, which is relatively nonpolluting, with coal, which is the reverse, would increase the already heavy stress on the environment in the region. So there is considerable anxiety about the effect conversion will have on the state's economy. A second article will discuss the potential conflicts between the Texas commitment to economic growth and its weaning from natural gas.—JOHN WALSH

Alaska Wilderness: Congress Debates Resources "Lock Up"

Next year Congress is expected to finally make the decision mandated by a 1971 law on bringing vast new acreages in Alaska into what is called the "four systems"—that is, the national systems of parks, wildlife refuges, national forests, and wild and scenic rivers. Already, the philosophical question of whether some potential hardrock mineral resources—and possibly some significant oil and gas resources—should be "locked up" in environmentally protected areas is posed more starkly than ever before.

Alaska's oil and gas potential has been an old story since the big strike in 1968 on the North Slope at Prudhoe Bay, and many people are aware that further exploration of this state's more than 20 sedimentary basins (of which only about a half-dozen have been explored so far) may lead to discovery of other major fields. While there are no large hardrock mining operations going on in Alaska today, the state is known by geologists as heavily mineralized and a likely place to find rich deposits of molybdenum, nickel, chrome, platinum, and the base metals copper, lead, and zinc. Some significant discoveries have in fact been made already, as for instance in the case of a large molybdenum deposit recently found in the Misty Fiords area in southeast Alaska's Tongass National Forest.

In light of the United States' increasing dependence on foreign sources for many metals, the mining industry wants all areas holding promise for future discoveries left open to exploration and development. And of course the petroleum industry, with existing domestic reserves of oil and gas undergoing rapid depletion, also wants ready access to all areas of promise, onshore and offshore.

From the standpoint of future mineral exploration and development, the problem in Alaska is that the mineralized areas often occur in regions of wild and scenic splendor—for instance, the Brooks Range, which lies between the North Slope and the Yukon Basin, and the Wrangell–St. Elias Mountains, a region of spectacular peaks, glaciers, and valleys in southeastern Alaska. Even oil and gas development that would occur in sedimentary basins well away from or on the periphery of the spectacular mountain massifs could lead to major conflicts with existing or proposed parks or refuges. The situation involving the Arctic Wildlife Range, which takes in much of the North Slope to the east of Prudhoe Bay, is a notable case in point. Whereas the range's geology is said to be favorable to discovery of "another Prudhoe Bay," exploration and development would inevitably disturb its wilderness character. The refuge is especially treasured because it includes the only part of the Arctic plain not yet visibly touched by the hand of man and it serves the Porcupine caribou herd of 125,000 animals as a calving ground.

Conflicts between development of mineral or oil and gas resources and wilderness preservation may arise even when they are not in direct contention for a particular area. For instance, an oil strike on the west side of the North Slope in the National Petroleum Reserve—where exploration is now in progress—could conceivably lead to demands to open another major pipeline and transport corridor across the Brooks Range.

The Carter Administration's Alaska lands proposal was presented to Congress by Secretary of the Interior Cecil D. Andrus on 15 September. It would have about 140 million acres—or nearly 40 percent of all land in Alaska—included in the four systems. There are some 48 million acres in parks, refuges, and national forests already, and the Administration would add another 92 million acres, with about 87 million going into parks and refuges and 5 million into national forests and wild river preserves.

Moreover, about 44 million acres in new and existing park, refuge, and national forest lands would be immediately classified for management as wilderness and kept roadless and free of all forms of development. Then, with completion of studies of the remaining land in the four systems over the next 7 years, several large additional areas would be proposed as wilderness.

The Alatna River, winding southward out of the Brooks Range, is one of the many scenic features of the proposed Gates of the Arctic National Park. [National Park Service photograph by M. Woodbridge Williams]

Existing mining and oil and gas development rights would be honored under the Administration's proposal, but otherwise (with a few minor exceptions) the national park and wild river areas would be closed to all mining and oil and gas development. The refuges also would be closed to mining, although those areas not classified or under formal study as wilderness would be open to oil and gas leasing at the discretion of the Secretary of the Interior. While the 22 million acres of existing and proposed national forest lands would be open to mining claims and oil and gas leasing, perhaps as much as a fourth or more of this acreage would in all probability ultimately be proposed as wilderness.

Ambitious as it is, the Carter Administration's Alaska lands proposal is not so ambitious as H.R. 39, the bill which Representative Morris Udall of Arizona (chairman of the House Committee on Interior and Insular Affairs) drafted in consultation with the Alaska Coalition made up of a dozen or more Alaskan and national environmental groups. This measure would add to the four systems about 20 percent more acreage than would the Administration proposal.

Yet, compared to the proposal tentatively put forward nearly 4 years ago by the Nixon Administration, the Carter Administration proposal is both larger in terms of acreage and more restrictive in terms of the development that would be allowed. Some of the new park areas that would be created are several times larger than Yellowstone National Park, which covers about 2 million acres and is the largest park in the "lower 48."

The aim has been to make the parks and refuges large enough to embrace entire regional ecosystems and watersheds and to preserve the unique quality that makes the Alaskan landscape so compelling. As Representative John F. Seiberling, the Ohio Democrat who chairs

the Interior subcommittee on Alaska lands, has put it, "There is no other place in the United States, and perhaps not in all of North America, where you can see vast landscapes as they came from the hand of the Creator, without any alteration by man."

The Alaska lands bill that has been introduced by Representative Don Young and Senator Ted Stevens (both are Alaska Republicans) represents a much more development-oriented approach. Under their measure, only 25 million acres would be added to the four systems, while 57 million acres of federal land would be placed along with state and some private lands under a "cooperative" program of multiple use management. The state would exercise a strong voice in this program through its representatives on a new federal-state land classification commission which would be established by this legislation. Needless to say, the mining and oil and gas industries are strongly behind the Stevens-Young bill; this bill may, however, be modified to increase the acreage for the four systems and to meet the objections of those in Congress who do not want the federal government to share jurisdiction over land management with the state.

Should Congress not act on the Alaska lands issue next year, the frustration of the state of Alaska and some of the Alaska natives' organizations in satisfying their land claims may be further prolonged. The Statehood Act of 1959 allows the state to select 103 million acres from the federal public domain, and the Alaska Native Claims Act of 1971 gives the natives the right to select 44 million acres.

But section 17(d)(2) of the Native Claims Act calls for a major expansion of the four systems before the end of 1978; consequently, final selection and patenting of most of the state's and some of the natives' land must await disposition of this so-called "d-2" lands issue. According to Robert Leresche, Alaska's commissioner of natural resources, the whole state land selection and patenting process is now caught in an "effective freeze."

Before its Alaska lands proposal finally jelled in mid-September, the Carter Administration engaged in a lively internal debate over some of the philosophical and practical aspects that were involved. On several questions, the last word was spoken by President Jimmy Carter himself.

Underlying the entire debate was the question of whether, as a matter of general philosophy and policy, even the most protected areas should be closed to exploration and development by the mining and oil and gas industries. In speaking to this question in interagency meetings called by the Office of Management and Budget (OMB), representatives of the Department of Commerce and the Federal Energy Administration (since absorbed by the new Department of Energy) generally reflected the industry point of view—which was, and is, that to forbid all commercial exploration and development in protected areas, short of such exceptions as Congress may see fit to grant in the future, amounts to locking them up.

Department of the Interior representatives, on the other hand, objected to this characterization. They contended that, except for U.S. Geological Survey (USGS) studies which need involve no scarring of the landscape, it was not necessary to allow exploration and development at this time. In their view, the

Cryptography Meeting Goes Smoothly

Albeit a little nervously, scientists went ahead as planned with two public sessions on cryptography despite the fact that an employee of the National Security Agency (NSA) warned that they could be in violation of the export and classification laws, which, he claimed, proscribe open discussion and publication of cryptographic research. The sessions were part of a 5-day meeting on information theory held last month at Cornell University.

The work of some of the principal speakers, including Ronald Rivest of the Massachusetts Institute of Technology (MIT) and Martin Hellman of Stanford University, derives from a study of complex mathematical problems, and has resulted in the design of a new class of codes, which could prove to be unbreakable—even with the application of billions of years of computer time.

The work has aroused commercial interest because of its implications for secure electronic banking and data communications. But it has also aroused the NSA, as became clear in September when an employee named Meyer wrote to the Institute for Electrical and Electronic Engineers (IEEE), the meeting's sponsor, threatening that the public discussion of the work and its publication could violate federal laws (*Science*, 30 September 1977).

After checking with lawyers, the scientists proceeded anyway, although they did limit their public discussion to the mathematical and technical aspects of cryptography and did not discuss, in their presentations, the possible national security applications of their work. In addition, because Stanford lawyers had advised Hellman they could defend him as a faculty member, but not his students, in the event of any subsequent prosecution, Hellman gave two papers on behalf of two of his students. The students came to the sessions, however, and were on hand to answer questions.

The scientists even laughed about the fact they have become controversial when an IBM researcher presented a paper explaining a computer program for decrypting text. The decrypted text, in successive slides, turned out to be the lead paragraph of an article that had appeared in *Science* about their dilemma.

More seriously, later in the meeting the Board of Governors of the IEEE Information Theory Group which sponsored the Ithaca gathering, appointed a subcommittee to study the issue and report back in December. The chairman of the group is David Slepian, of Bell Laboratories, Inc., who is on leave at the University of California at Berkeley. The members are Thomas Cover of Stanford and Rudolph Drenick of the National Science Foundation (NSF).

The successful conclusion of the two cryptography sessions left little doubt that the work has been widely circulated. It has been published in several journals with international circulation including *Science* (19 August 1977), and the IEEE sessions were attended by a Russian, three Hungarians, and scientists from the Republic of China (Taiwan), France, and Sweden. There were also several industry people, and people with name tags indicating that they worked for the military. One displayed a label that said only "Department of Defense—Maryland"—a phrase believed to be a code word for the NSA.—D.S.

mining and oil and gas industries would have more than enough land to investigate for years to come. They pointed out that about 60 percent of Alaska would be outside the four systems. Moreover, an immense area—229,000 square miles altogether and larger than the states of California and Washington combined—would be under state and native jurisdiction and much of it presumably would be open to development.

In addition, the Interior representatives argued that, wherever areas known to be of high mineral or oil and gas potential could be excluded from park or refuge boundaries without jeopardizing the environmental integrity of the units in question, this had indeed been done. To this end, Interior's Alaska lands task force—headed by Cynthia Wilson, formerly the National Audubon Society's Washington representative and now a member of Secretary Andrus' personal staff—had made extensive use of a computerized resource assessment study done by Alaska's Department of Natural Resources.

This study indicated the extent to which various resources would be affected by the several earlier d-2 land proposals, such as H.R. 39 and the Stevens-Young bill. Its weakness was that except in a few selected areas, neither the USGS nor the mining and oil and gas industries have gone far in their investigations of the resource potential of Alaska. The USGS has published mineral resource maps for only three of the 41 quadrangles it has scheduled for study by 1990, and even when all these maps are finally in hand they will only identify areas in which further exploration might lead to discovery of mineral deposits of commercial significance. The industry view is that, given how little is known, few if any areas should be closed to commercial prospecting or exploration.

Nonetheless, President Carter concluded that Interior had the better of the argument. "The President was persuaded that the Interior proposal itself represented a careful effort at balance," a White House aide told *Science*.

In one instance, the President specifically approved the department's plan—in which some OMB staff people felt Interior might be giving up too much—to mollify native interests. The natives were afraid that establishment of the proposed Gates of the Arctic park would interfere with their selection of land in the Killik River watershed regarded as rich in oil and gas. Interior's plan called for excluding from the park most of the land overlying the potential oil and gas structure and, further, offering the natives subsurface rights beneath beautiful Kurupa Lake and the Killik River corridor—rights that would permit such petroleum resources as might be present to be tapped by wells drilled on a slant from outside the park and wild river boundaries.

Eskimo hunters haul away a seal kill in the proposed Cape Krusenstern National Monument, where subsistence hunting would be allowed to continue. While such hunting remains important to Alaska natives, they have become increasingly a part of the cash economy and have a stake in the development of Alaska's mineral and oil and gas resources. [*National Park Service photograph by Robert Belous*]

Another question decided by the President had to do with whether, in certain circumstances, the Secretary of the Interior should be allowed to permit the establishment of transportation corridors through parks and refuges without first going to Congress and asking for authority. As in the case of the general philosophical question about locking up resources, Carter accepted Interior's argument. Essentially, it was that, inasmuch as Congress establishes a park or wilderness to confer upon an area a protected status, that status should be significantly changed only by Congress itself.

The only other question decided by the President himself was whether opening the Arctic Wildlife Range to oil and gas exploration and development should continue to be left to the discretionary authority of the Secretary of the Interior—or whether, as Andrus proposed, Congress should classify the range as wilderness. Whereas there was something abstract or hypothetical about the other questions presented to him, this one had concreteness and immediacy. "It involved the clearest, starkest choice," the White House aide observed.

But, again, Carter agreed with Secretary Andrus and Interior that, for the moment, wilderness and wildlife values outweighed the value of oil and gas resources and that, while the scales might tip the other way later, the reweighing should be left to Congress rather than to some future secretary.

There seems a good chance that an Alaska lands bill generally along the lines of the Administration proposal will be reported out of the full Committee on Interior and Insular Affairs in time for House action sometime in the first half of 1978. The Seiberling subcommittee has held hearings this year not only on Capitol Hill and in six cities in Alaska, but also in Atlanta, Chicago, Denver, and Seattle.

The turnouts were large, and—except at some of the field hearings in Alaska—strong support was voiced for preserving much of Alaska as undisturbed wilderness. Indeed, as Guy R. Martin, formerly Alaska's commissioner of natural resources and now assistant secretary of the interior for land and water resources, has put it, a "gigantic constituency exists for setting aside a lot of land in Alaska in protected categories."

But a fight can be expected in the House—and later in Senate committee and floor deliberations—over the same questions about locking up resources debated within the Carter Administration. By invoking the "energy crisis" and the possibility of future mineral shortages, the Alaskans in Congress—with powerful support from groups such as the American Mining Congress and the Western Oil and Gas Association—may in fact be able to have the pending

legislation amended much more to their liking.

For his part, Representative Seiberling, whose subcommittee will begin marking up the Alaska lands legislation any day now, is not of a mind to offer substantive concessions to those who speak of a resources lock-up. But he would have the legislation prescribe expedited congressional consideration of any future request by a President to open up certain protected areas in Alaska to resource exploration and development or to transportation corridors—provided, however, that the justification for such requests be convincingly documented.

More important in terms of the politics of getting a bill through Congress, Seiberling also now shrewdly proposes that the same legislation which settles the d-2 lands issue also convey to the state and to the natives all land patents to which they are entitled.

But, whatever Congress finally does about the Alaska lands issue, the impending debate over just how far Congress should go in raising barriers to development of pristine natural areas is likely to be audible and intense. From this debate the public may get a sharpened appreciation of the dilemmas that are involved.—LUTHER J. CARTER

RECENT DEATHS

Oscar Bodansky, 76; biochemist and former vice president, Sloan-Kettering Institute for Cancer Research; 21 August.

Albert S. Coolidge, 83; former professor of physics, Harvard University; 31 August.

Clarence M. Ferguson, 78; professor emeritus of agriculture, North Carolina State University; 11 August.

A. H. Gayton, 77; professor emeritus of design and anthropology, University of California, Berkeley; 18 September.

Alphaeus M. Guhl, 79; professor emeritus of biology, Kansas State University; 25 August.

W. H. Horr, 85; professor emeritus of biology, University of Kansas; 12 March.

Aleksandr R. Luria, 75; Soviet neuropsychologist and former head, Moscow Institute of Defectology; 14 August.

John H. Moss, 58; professor of geology, Franklin & Marshall College; 28 July.

John R. Pellam, 62; professor of physics, University of California, Irvine; 23 July.

John T. Maynard, 58; chemist and head, Elastomer Chemicals Department Patent Service, E. I. Du Pont de Nemours & Company; 17 September.

Harold C. Zweng, 54; clinical professor of surgery, Stanford University Medical School; 26 August.

APPOINTMENTS

David B. Ludlum, professor of pharmacology and experimental therapeutics, University of Maryland, to chairman of pharmacology and experimental therapeutics, Albany Medical College. . . . **Ruy V. Lourenco**, professor of medicine, University of Illinois at the Medical Center, to chairman of medicine, Abraham Lincoln School of Medicine at the university. . . . **Charles I. Smith**, chairman of geology-mineralogy, University of Michigan, to chairman of geology, University of Texas, Arlington. . . . **Robert N. Rose**, professor of psychiatry, Boston University, to chairman of psychiatry, University of Texas Medical Branch, Galveston. . . . **James F. Arens**, chairman of anesthesiology, University of Mississippi, to chairman of anesthesiology, University of Texas Medical Branch, Galveston.

RESEARCH NEWS

High Energy Physics: A Proliferation of Quarks and Leptons

Determining the fundamental constituents of matter has been one of the age-old problems of physics. Currently the most popular view—although there are holdouts—is that particles known as quarks and leptons are the most fundamental of all. But, if the interpretations given the most recent experiments at accelerators in the United States and Europe hold up, the number of these basic particles is showing a disturbing tendency to grow—disturbing because, whenever the number of elementary particles begins to increase, it usually means that they are not really elementary after all.

Illustrating this pattern well is the class of protonlike elementary particles called hadrons, which also includes the neutron and the pi meson. Experimentalists have found so many hadrons (literally hundreds) in the last quarter-century that the concept of an elementary particle no longer seemed to fit these entities. Although no quark has ever been unambiguously found, all the properties of hadrons can be elegantly explained under the assumption that quarks exist and are the even more fundamental constituents from which hadrons are formed. For this, as well as certain other reasons, physicists' faith in quarks is very strong right now.

Originally there were three quarks, but the discovery 2 years ago of the J/psi particle, a hadron, and the subsequent particles related to it have been widely accepted as evidence for a fourth quark. What one of the new experiments reveals is the possibility of there being five or even six quarks. Confirming evidence in the coming months could also cement the acceptance of a new meaning for high energy physics. Just as the mantle of high energy physics was once worn by nuclear physics but passed years ago to elementary particle (hadron) physics, so now it may be passing from elementary particle physics to quark physics as more powerful accelerators probe more deeply into the heart of matter.

The discovery of the J/psi particle also capped an emerging realization of a particularly efficient way of searching for elementary particles of a certain type. This method has been used by a collaboration of physicists from Columbia University, the Fermi National Accelerator Laboratory (Fermilab), and the State University of New York at Stony Brook in their discovery of the most massive elementary particle yet found. Dubbed the upsilon, it is this particle that may indicate the existence of a fifth and (possibly) sixth quark. The group did their experiment at the Fermilab's 400 billion electron volt (Gev) proton accelerator.