research, examination shows that $13 million was spent by the Defense Department for aircraft, weapons, and equipment, including a tank that is being developed in cooperation with West Germany and a short-takeoff aircraft developed in cooperation with Great Britain; that NASA spent $6 million for tracking stations; and that the AEC spent $3 million for long-term medical follow-up of radiation effects in Hiroshima. Another $11 million was in counterpart funds from agricultural sales abroad, and $7 million went abroad but came back to the U.S. for purchase of equipment. That leaves $30 million in hard cash going abroad—a large sum, but can it be reasonably argued that dollar-drain considerations, rather than the effects in terms of scientific results and foreign goodwill, should dominate the use of this money?

Reuss's first press release was followed last week by a statement listing four additional research projects and charging that "four major agencies awarded over $25 million in research contracts to foreign scientists for research outside the United States." The congressman was quoted as saying, "I love science and I love the world, but I think prudence is in order until our balance of payments are under control."

The congressman issued the statements in his capacity as chairman of the Research and Technical Programs Subcommittee of the House Government Operations Committee, which opened hearings last week on the allocation of federal funds for research and development.—D.S.G.

Earthquake Prediction: ESSA and USGS Vie for Leadership

The Environmental Science Services Administration (ESSA), an ambitious new agency established last July (*Science*, 11 June 1965), is receiving questioning glances, and sometimes anxious ones, from the U.S. Geological Survey (USGS). ESSA, an agency of the Department of Commerce, and USGS, an agency of the Department of the Interior, are rivals for the management of the earthquake prediction program recommended in October by a panel of distinguished scientists.

The stakes could be large. Although no program has yet been defined and approved by the Johnson administration, it is difficult to conceive of a major earthquake prediction effort costing less than $100 million. This is big money for agencies such as ESSA and USGS, which for the current fiscal year are receiving, in direct federal appropriations, $144.7 million and $72.7 million, respectively.

President Johnson has said that ESSA will "provide a single national focus to describe, understand, and predict the state of the oceans, the state of the upper and lower atmosphere, and the size and shape of the earth."

Just how this mandate should be interpreted is likely to be the subject of a good many man-years of disputation and debate. Interagency rivalries in the earth sciences, oceanography, and perhaps other fields, such as weather modification, can be expected. Federal interest in science-oriented programs is growing as productive scientific activity increases. But, because some programs do not fit easily into conventional agency-mission categories, they often are up for grabs.

ESSA was formed by consolidating three Department of Commerce activities—the Weather Bureau, the Coast and Geodetic Survey (CGS), and the Central Radio Propagation Laboratory (CRPL). Though now under consolidated management, the Weather Bureau and CGS each continues to function under its own name. ESSA also has an Environmental Data Service, a National Environmental Satellite Center, and the Institutes for Environmental Research, made up of the Institute for Telecommunication Sciences and Aeronomy (formerly CRPL), the Institute for Atmospheric Sciences, the Institute for Oceanography, and the Institute for Earth Sciences.

The Administrator of ESSA is Robert M. White, former chief of the Weather Bureau, who is highly regarded among meteorologists. A prime mover in ESSA's formation was the Commerce Department's Assistant Secretary for Science and Technology, J. Herbert Hollomon, a dynamic official who sets a fast pace for science advisers and administrators in other government departments.

If the Johnson administration decides to undertake an earthquake prediction program, Hollomon wants ESSA to manage it, though he says no campaigning is being done to get ESSA the job. The need for a prediction system was pointed up by the Alaska earthquake of 1964. Donald F. Hornig, President Johnson's science adviser and director of the Office of Science and Technology, appointed a panel headed by Frank Press, geophysicist and now a departmental chairman at M.I.T., to study the problem.

The Press committee issued its report in October (*Science*, 15 October 1965). It recommended a $137-million program of earthquake research and earthquake engineering, which would require 10 years to complete. Although conceding that success was not assured, the panel expressed the belief that its proposal offered a fair chance of developing an earthquake warning system. The effort would be focused on Alaska and California, the nation's two most seismic regions. Instrumentation would be placed in fault zones, and field studies would be conducted. More than half the $137 million would be spent on instrumentation.

Hornig's office still has the panel's recommendations under study, but a decision on the kind of program to be undertaken is expected within a few months. Although budgetary pressures generated by the Vietnam war make the time unfavorable for the launching of costly new programs, some initiatives in earthquake research are likely. The first year's outlay under the Press proposal would be comparatively modest—about $13 million, with $7.2 million for instrumentation. Earthquake research already has been stepped up by both ESSA and USGS, in part by the reprogramming of available funds.

If the White House and Congress authorize the initiation of a large earth-

J. Herbert Hollomon (left), Assistant Secretary of Commerce for Science and Technology, and Robert M. White (right), Administrator of the Environmental Science Services Administration.

quake program in either 1966 or a subsequent year, settlement of the competition between ESSA and USGS for the management role appears inevitable. Presumably, the primary management responsibility will be given to one agency or the other, or a mechanism by which the management responsibility can be shared will be developed.

In considering who should manage the program, two questions are raised: (i) How does earthquake prediction relate to traditional agency missions? (ii) Which agency has the greater scientific competence for earthquake research?

Two of ESSA's component units—the Weather Bureau and the Coast and Geodetic Survey—are the traditional agencies for the issuance of warnings about environmental hazards. CGS, one of the oldest technically oriented agencies in the government, has been operating a worldwide system of seismograph stations and a seismic seawave warning system in the Pacific. The popular view at the Geological Survey is that CGS's proper function in the earthquake program should be to continue, and to expand, its traditional collecting and cataloging of seismic data.

But in November ESSA announced the creation of the Institute for Earth Sciences, which is made up of about 40 people from CGS and which is, in a sense, an adjunct to CGS for fundamental research. Under the direction of Leroy R. Alldredge, who joined CGS as a research geophysicist in 1959, the institute will investigate the properties of the earth's interior and try to develop earthquake-prediction methods. One of the institute's components is an Earthquake Mechanisms Laboratory at San Francisco, headed by Don Tocher, formerly a research seismologist at the University of California.

The Geological Survey's claim to leadership of the earthquake prediction program rests largely on the extent of its scientific resources and on its long research experience in the area of geological relationships and terrestrial dynamics.

On 8 October, 2 days after the Press panel report was made public, the Interior Department announced the establishment within USGS of a National Center for Earthquake Research at Menlo Park, California, near the San Andreas fault in the western earthquake belt.

In the current issue of *Geotimes*, journal of the American Geological Institute, USGS director William T. Pecora says the center will provide "an effective means of bringing together into a directed program of research, the diverse talents of the relatively few experts now scattered through federal and state agencies, universities, and private research institutions both within and outside the United States."

In addition to the earth scientists already engaged in research at Menlo Park for USGS, the Survey's Branch of Crustal Studies is moving 40 employees, including 25 geophysicists, to Menlo Park from Denver. According to Pecora, the center will be exceptionally strong in nearly all aspects of geology, geophysics, and geochemistry, and will be "the outstanding single group with broad experience in earthquake investigation." Louis C. Pakiser, former chief of Crustal Studies, has been named chief scientist in charge of the center.

ESSA cannot compare with USGS in strength of resources for earthquake research. USGS's geologic division has some 900 geoscientists, of whom more than 360 are Ph.D.'s—nearly three times the total number of ESSA's Ph.D.'s in meteorology, oceanography, geodesy, and other disciplines combined. The Coast and Geodetic Survey and the new Institute for Earth Sciences together have 25 Ph.D.'s, of whom two are geophysicists and six are seismologists. (Alldredge, the institute's director, hopes that, over the next several years, his present staff of 40 will grow to perhaps 200. He wants to maintain the proportion of professionals at half or more of the total, and he wants half of the professionals to be Ph.D.'s.)

"Earthquake prediction is more related to ESSA's purposes, but ESSA is not staffed for the mission," commented a prominent geophysicist. "Most scientific people are persuaded by where the talent lies. They've seen projects, well placed from the standpoint of an agency's mission, fail for lack of talent." Scientists who feel that USGS should manage the earthquake program usually observe that the Coast and Geodetic Survey cannot match the close ties USGS has with the academic community. (The fact that CGS formerly was run by uniformed officers made it more difficult to bring about ready exchanges of scientific talent with the universities, some scientists believe. Now that CGS has been brought under the same administrative roof with the Weather Bureau and other nonuniformed agencies, this impediment may disappear.)

Hornig's office has received numerous urgings from geologists in support of having USGS manage the earthquake program. Many of these overtures were stimulated by some effective buttonholing by USGS officials at last fall's meeting, in Kansas City, of the Geological Society of America (GSA) and the American Geological Institute (AGI). Armand J. Eardley, the outgoing president of AGI, has endorsed the

program recommended by the Press panel and has said that it should be administered by the USGS.

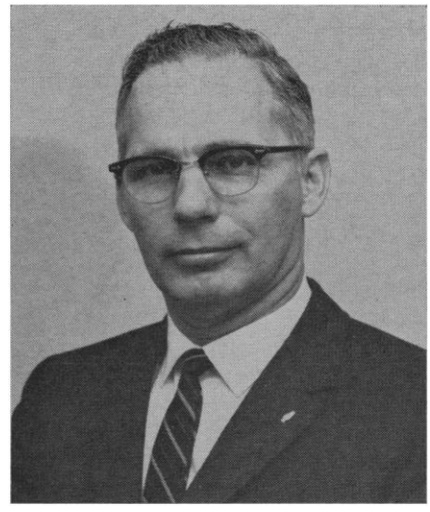
Ian Campbell, chief of California's division of mines and geology and president of the Association of American State Geologists, said the earthquake prediction program should be conducted by USGS and not scattered among several agencies. He said the basic investigations, measurements, and processing and interpretation of data could best be done by a single agency.

Robert A. Frosch, a member of the Press panel and deputy director of the Defense Department's Advanced Research Projects Agency (ARPA), which administered the Vela Uniform project in underground nuclear test detection, is understood to favor USGS for the management role, though he does not confirm this. In Vela Uniform, ARPA relied in part on both USGS and the Coast and Geodetic Survey.

Another member of the Press panel, Harry H. Hess, chairman of the geology department at Princeton and a past president of GSA, told *Science* last week that he does not care particularly which agency manages the earthquake prediction program. Hess said he has written Hornig endorsing USGS's plans for earthquake research at Menlo Park and urging that the Coast and Geodetic Survey be strengthened scientifically. He said that, in the earthquake program, CGS should be more than a service organization confined to the unexciting tasks of operating seismograph stations and cataloging data.

Hollomon, Commerce's enthusiastic assistant secretary, says it was at the request of the President's Science Advisory Committee (of which Hornig is chairman) that ESSA submitted a plan showing how it could manage the earthquake prediction program. "Somebody has to have systems responsibility for the program, and we have proposed that ESSA is an appropriate agency," said Hollomon, in an interview with *Science*. "But I'm not running around the government on a white charger trying to establish a program responsibility for the earthquake prediction business.

"I don't think it's terribly important who coordinates the program so long as it is recognized that the final judgment as to when, and under what conditions, earthquake warnings go to the public remains an ESSA responsibility," Hollomon said. "If we are to issue warnings, it is essential that we have a strong role in the prediction program because one day we will have to use the results."



Leroy R. Alldredge

Hollomon said that, aside from any earthquake prediction program, ESSA needs to strengthen itself in the earth sciences for the sake of its existing programs in seismology and geodesy. "Every major harbor in Alaska has had to be recharted because of the earthquake," he said. "Every major geodetic line in the region has had to be redone. How in the world is ESSA going to do this intelligently unless it understands the character of the changes in the earth that take place? That does not mean that ESSA must have all of the geophysics and geochemistry, or even most of it, that the Geological Survey has. It would be silly to reproduce the Survey's staff."

Hollomon observed that, with respect to certain aspects of the earthquake prediction problem, such as developing techniques for measuring small distortions, neither ESSA nor USGS is competent enough. "If there is to be a major earthquake prediction program, ESSA, USGS, the National Science Foundation, and the universities all must increase their competence and their personnel in the earth sciences," he said.

Hollomon acknowledged with a smile that, with the creation of ESSA, he has created a stir among the officials responsible for scientific activities throughout the government. Some people refer to him as an empire builder, but he waves the suggestion aside. "I'm not going to stay in the government forever," he said. "So who would I be building an empire for? The only thing I want to contribute while I'm here is institution building—to leave behind me more effective, stronger, more serviceable institutions."

Suspicions sometimes are voiced that Hollomon would like to see ESSA absorb the Geological Survey and serve eventually as the framework for a Department of Science and Technology. As for absorbing USGS, Hollomon neither affirms nor rejects the idea, but says: "If the President's office or anybody else wants to undertake a study of any kind of organization that affects us, presumably we'll be asked for our advice and we'll give it."

Hollomon is opposed to any reorganization of government science that would take from the various agencies the scientific programs which are necessary to their missions. He is not sure, however, that a Department of Science and Technology would be incompatible with the continued integration within agencies of those science programs essential to agency missions. "It's conceivable to me, but I don't know," he said.

Lloyd V. Berkner, director of the Southwest Center for Advanced Studies and an advocate of more consolidation of government science, was chosen to deliver the principal address at an ESSA ceremony last October. Berkner indicated that the consolidation achieved by ESSA was but a step down a long road. "We cannot rest until the task is complete," he said. "Other areas of environmental science are still disconnected, still having gaping crevasses in the continuity of our environmental services."

As an Interior Department official—one concerned lest ESSA take over the management of the earthquake prediction program—recently observed, "The ESSA concept is not one that will stop where it is now."—LUTHER J. CARTER

Announcements

People who want to try **changing the weather** after 1 February have to give the National Science Foundation a month' notice. An NSF regulation that went into effect this month requires 30 days advance notice from anyone planning "activities aimed at modifying the atmosphere." The ruling applies both to commercial cloud seeders and to scientists. Failure to comply could bring fines of up to $500. Notifications should be sent to Peter H. Wykoff, NSF, Washington 20550.

In addition to anouncing their at-