these precautions would be wise, although the risk of triggering a large earthquake would not be eliminated altogether by increasing shot yields gradually. According to Frank Press, even a low-yield shot might be sufficient to release the energy which has naturally accumulated along faults where strains exist. Under its present plans, the AEC obviously will not be increasing shot yields by modest increments. Only three test holes have been drilled on Amchitka, one for this fall's 1-megaton calibration test, the remaining two for the testing of weapons too powerful to be detonated safely in Nevada.

F. R. Tesche, deputy director of the AEC's division of military applications, says that the agency's ad hoc panel on seismology, chaired by James T. Wilson of the University of Michigan, believes that the Amchitka test program does not involve an unreasonable risk. However, in response to inquiries by Senator Gravel, two members of that panel, Clarence R. Allen of Caltech's Seismological Laboratory, and Jack Oliver of Lamont-Doherty Geological Observatory, have endorsed the senator's proposal to establish an independent body of experts on nuclear testing and seismic safety. Furthermore, Allen said, "my confidence in [the safety of the Amchitka tests] would be much increased if our geological and geophysical knowledge of the area were greater, and if we were to progress to the large events by a series of increasing steps."

The AEC is responding to the recommendations for seismic monitoring. According to Tesche, five seismic stations are being established on Amchitka, two others are being set up on neighboring islands, and an as yet undetermined number will be installed on the seabed. The ad hoc panel, he says, is generally satisfied with the seismic network being established. Everything depends, Tesche adds, on the results of Milrow. "If anything coming out of this test is a substantial deviation on the worrisome side, AEC will not be able to continue," he says.

The possibility of large earthquakes and tsunamis being induced by nuclear tests is being cited by advocates of arms control. In an open letter to President Nixon, the Educational Committee to Halt Atomic Weapons Spread in early July urged that the United States seek a treaty banning all underground tests large enough to register above the "threshold" of 4.5, the seismic magnitude produced by a 10-kiloton shot fired in granite. The 1.1-megaton Benham shot, fired in a porous volcanic tuff, produced a seismic magnitude of 6.3. Seismic magnitudes vary widely, however, depending on whether a shot is fired in hard rock, in tuff, or in other material.

A number of prominent scientists, including Jerome Wiesner of M.I.T., George Kistiakowsky of Harvard, and Nobel laureate Polykarp Kusch of Columbia, were among the signers of the letter to Nixon. Among the reasons the letter cited for restricting underground testing were the possibility of accidental venting of radioactivity and the earthquake hazard.

On 31 July, a proposal to restrict testing was submitted by Japan to the Eighteen Nation Disarmament Conference in Geneva. The Japanese would fix the threshold at seismic magnitude 4.75. The concept of a threshold treaty is long familiar, but there has been renewed interest in it since June 1968 when the International Institute for Peace and Conflict Research in Stockholm (SIPRI) released the report of its seismic study group. According to the report, British, Canadian, American, and Soviet research indicates that the world's seismic networks will be able to identify positively nuclear explosions at yields down to 10 kilotons (fired in hard rock), thus distinguishing them from natural earthquakes. The SIPRI finding allows hope of avoiding the troublesome "on-site inspection" issue, on which proposals for banning all underground testing have foundered; the Soviet Union rejects the idea of allowing foreign inspectors to come on its territory to investigate suspicious seismic events.

It appears that the prevailing view among Nixon Administration officials who have considered the matter is that a threshold treaty would be difficult to negotiate—and, if somehow negotiated, hard to monitor without frequent quarrels over disputed interpretations of seismic data. And, further, that it would in any event have far less value as an arms-control measure than a treaty banning all nuclear tests. To stimulate progress in test detection and verification, the United States has proposed that seismic stations throughout the world closely monitor a 40-kiloton shot next month in Colorado demonstrating use of a nuclear explosion to increase recovery of natural gas.

All proposals for banning underground tests now appear to have a low priority on the U.S. arms-control agenda, for the proposed U.S.–Soviet talks on the limitation of strategic arms are still pending and several key nations—Japan, India, Israel, and West Germany—still have not signed the Nuclear Nonproliferation Treaty. Recently, the question of environmental hazards has stimulated increased public interest in the underground testing of nuclear weapons. But unless one of the forthcoming Amchitka shots happens to produce a disaster, the kind of public outcry that contributed to the success of efforts to ban tests in the atmosphere seems unlikely to occur.

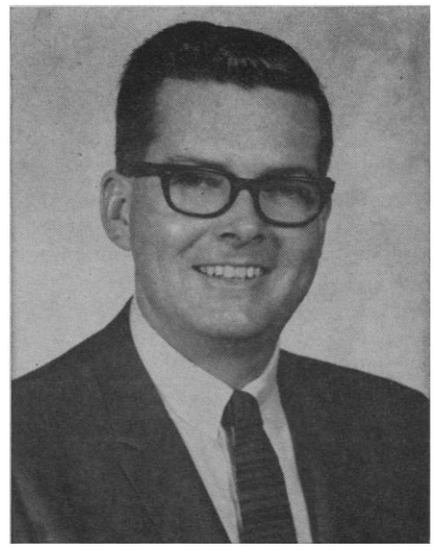
—LUTHER J. CARTER

Trouble at NASA: Space Scientists Resign

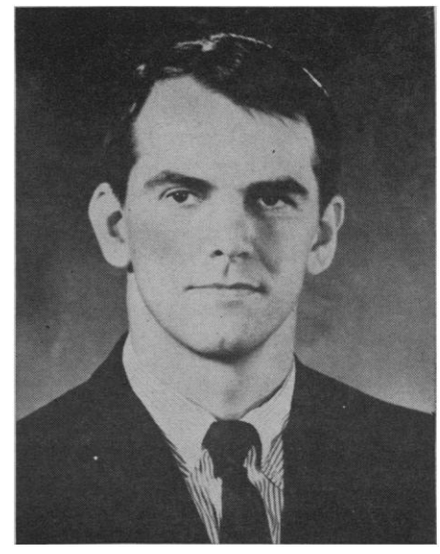
The resignation of three top space agency scientists and a scientist-astronaut came to public attention recently in the wake of NASA's most glittering success—the Apollo 11 manned lunar landing. The resignations, which NASA officials say represent a "serious loss" to the agency, occur at a time when there is an undercurrent of dissatisfaction among scientists in general over NASA's alleged neglect of important pure science research goals in favor of engineering pursuits and the more glamorous technical aspects of space exploration. But the reasons for the resignations of the space scientists are complicated and seem not to be based on a single motive of disenchantment with NASA policies.

The four scientists leaving the program are Wilmot Hess, science director of the Manned Spacecraft Center in Houston; Elbert King, curator of the Lunar Receiving Laboratory in Houston; Donald Wise, deputy director of Apollo Lunar Exploration at NASA headquarters in Washington; and scientist-astronaut Curtis Michel,

Wilmot N. Hess



Elbert A. King



Curtis Michel

a physicist at Houston. King, Michel, and Wise will return to academic life, and Hess will remain in government as director of the research laboratories of the Environmental Science Services Administration in Boulder, Colorado.

With the Apollo landing accomplished, these scientists have made it known that they have feelings of frustration about the space program, but they have been reluctant to criticize NASA publicly. In interviews with *Science*, two of the space scientists and the scientist-astronaut (Hess refused to talk about his resignation) declined to attribute their resignations directly to major dissatisfactions with the space agency; they denied that they were quitting to protest an emphasis by NASA on engineering rather than scientific research. Two of them expressed concern that their resignations might trigger a berating of NASA by scientists that might produce an end result more harmful than good for the future of pure science in the space program. The scientists did, however, express some dissatisfaction with the role of basic science in space exploration, and impatience with NASA's management of scientific projects. Unquestionably, one element in the resignations is the scientists' disenchantment with their own roles as government administrators; they feel more at home in their natural habitat, the university. They also admitted that they are lured by the prospects of new, promising positions that offer them more time to devote to their own research.

NASA officials say the resignation of four of the agency's top scientists is a "critical problem." The resignation of Hess was described as a "surprise," and the departure of Wise was said to be "earlier than expected." The other two, Michel and King, had expressed some time ago their intentions of leaving NASA.

The four scientists are apparently highly regarded in the space program. Hess was brought to Houston by NASA 2 years ago, to upgrade the role of scientific research in the space program. King was instrumental in creating the Lunar Receiving Laboratory and the Lunar Sciences Program in Houston. Wise is described by space scientists in Houston as "an inside man who understands science" and is a major proponent for scientific programs at NASA headquarters. Michel is considered a competent space physicist.

The Lure of Academe

In a telephone interview, King said he decided in April to leave NASA to return to the academic community to a job opportunity he regards "as interesting and potentially rewarding." (He will head the geology department at the University of Houston.) King denied that there is widespread dissension among scientists in Houston, and said that if there is a general feeling of dissatisfaction, it is the feeling that scientist administrators have very little time to devote to their own scientific research.

In commenting on the space program in general, King said it was not unreasonable for NASA to have emphasized engineering capabilities over scientific pursuits before it had achieved its goal of sending men to the moon, but he believes that future landings, including those in the Apollo program, should shift to greater emphasis on attaining scientific objectives.

King suggested that the agency pay more attention to the scientific priorities set up by study panels of the National Academy of Sciences, and expressed concern that "recommendations often get lost in the maze of scientific management." The scientific community "must still be convinced that NASA will put together a program that will truly emphasize science," King said. Earlier this month, King opposed a plan by President Nixon to give lunar dust as gifts to foreign heads of state. He said it would be a great misuse of the lunar material if a significant amount were used for purposes other than science and public display.

Curtis Michel, who has been in the scientist-astronaut program since 1965, told *Science* he was resigning "with regret" because he wanted to devote more time to scientific research and because his opportunities for a space flight "look quite dim." Michel said there is no one-to-one correspondence between his resignation and dissatisfaction with NASA priorities, although he said he supposed his disappointment with space flight opportunities *was* a "reflection of disappointment that engineering is emphasized over science." Michel, who is returning to Rice University as a full-time assistant professor of physics, said he is disappointed that NASA management has shown "no serious intent to fly scientist-astro-

nauts. At some point they should fly science observers, and the sooner the better," he added. No scientist-astronauts have been scheduled to fly in any of the announced future missions.

At NASA headquarters, Donald Wise said he resigned from NASA because he wanted to return to the academic community and to his responsibilities there. Wise, who will become a visiting professor of extraterrestrial geology at the University of Massachusetts, characterized NASA as an agency that grew quickly and that considers science just one small part of its many functions. He said the space agency's main problems are inadequate manpower for keeping track of the scientific programs, insufficient funding by Congress, inadequate long-range planning, the juxtaposition of scientific goals and political and engineering interests, and lack of understanding of scientific goals at the management level in NASA. In discussing the agency, Wise said he was proceeding with caution. He expressed concern that the scientific community "by its criticism will create additional problems."

Potential vis-à-vis Reality

"There is a difference between potential and reality," Wise said; "We don't want to lose the reality by lamenting the potential. With enough screams, we will fly only five missions instead of ten—this would be the real tragedy." Wise stressed scientific cooperation within the agency. "We [scientists] have to live with engineering groups. We can't just say we're picking up our marbles and going home. This attitude degrades what little science we can get out of it. Personally I'm frustrated," Wise concluded, "but I'm loath to really kick [the space program] for fear of doing more harm than good."

Commenting on the resignations, Henry Smith, a NASA Deputy Associate Administrator for Space Science and Applications, told *Science* that Hess was known to have shown disappointment over the amount of scientific research included in the lunar programs, but that his resignation was "a surprise to the agency." He called Hess's resignation "critical," and indicated he would be a hard man to replace. Smith said he can foresee "no widespread dissatisfaction or mass exodus of scientists from NASA," but did admit that the agency has a continuing problem in recruiting good scientists for science-administrative positions. Wise's resignation, Smith said, is an example of a scientist's preference for research activities and academic life over a government administrative position.

Michel is not the only scientist-astronaut who quit the program to devote more time to scientific work. Brian O'Leary resigned from the program last year to take a position as a professor of astronomy and space sciences at Cornell. In a letter to the New York *Times* and the Washington *Post* last week, O'Leary said "The gap between science and engineering in NASA's manned space program seems to be widening, and the scientists are coming out on the short end." O'Leary said the "most dramatic" example of this "regrettable situation" was the announcement of the Apollo 13 and Apollo 14 crews. "Each crew includes two rookie test-pilot astronauts," who joined the program more recently than several of the scientist-astronauts, O'Leary said. (NASA officials say O'Leary resigned from the program last year because he did not wish to become a pilot. In the official announcement of his resignation, O'Leary is quoted as saying, "Flying just isn't my cup of tea.")

Of the half dozen other NASA scientists interviewed, *Science* found all were disappointed that there is not more scientific research, particularly in the lunar programs. The attitude seems to be that NASA could and should do more scientific research than it does.—MARTI MUELLER

APPOINTMENTS

J. Stanley Marshall, acting president of Florida State University, elevated to president of the university. . . . **Monto Ho**, professor of epidemiology and microbiology, University of Pittsburgh, to chairman, epidemiology and microbiology department. . . . **Roger L. Mitchell**, professor of agronomy, Iowa State University, to chairman, agronomy department, University of Missouri, Columbia. . . . **Abraham Mazur**, professor of chemistry, City College, City University of New York, to chairman, chemistry department at the college. **Frank Harrison**, acting president, University of Texas, Arlington, elevated to president at Arlington. . . . **Francis S. Johnson**, head of the atmospheric and space sciences division, Southwest Center for Advanced Studies, to acting president of the SCAS, soon to be the University of Texas, Dallas. . . . **James B. Bartoo**, head, statistics department, Pennsylvania State University, to dean, Graduate School at the university. . . . **Robert H. Heptinstall**, acting director of the pathology department, has been elevated to director of the pathology department at the Johns Hopkins University School of Medicine and pathologist-in-chief for the Johns Hopkins Hospital.

RECENT DEATHS

Margaret M. Dickie, 47; genetic mutations specialist, Jackson Laboratory, Maine; 4 July.

Frederick D. Drew, 56; radiologist and associate professor, College of Medicine, Howard University; 12 July.

L. William Earley, 52; former professor of psychiatry, University of Pittsburgh School of Medicine; 14 July.

Eduard Farber, 77; former chief chemist, Timber Engineering Co., and consultant to American University; 16 July.

Leon H. Johnson, 61; president of Montana State University; 18 June.

Rene Leviticus, 69; former professor of radiology, New York University; 3 July.

Harald Norinder, 81; former director, Institute for High-Tension Research, Uppsala University, Sweden; 6 July.

Cecil F. Powell, 65; nuclear physicist and Nobel Prize winner; 9 August.

Dorothy Rethlingshaefer, 72; professor of psychology, University of Florida; 25 July.

John S. Richardson, 60; professor of science education, Ohio State University; 22 May.

Earl Suitor, 38; microbiologist, Naval Research Institute, Bethesda, Md.; 12 July.

Friedrich Wasserman, 84; emeritus scientist, biological and medical research division, Argonne National Laboratory; 16 June.

Charles S. White, 92; co-founder of Doctors Hospital, Washington, D.C.; 12 August.

Martin H. Wittenborg, 55; associate clinical professor of radiology, Harvard University Medical School; 10 August.

Fletcher D. Woodward, 74; professor emeritus of otolaryngology, University of Virginia; 2 July.