News of Science

Development of International Efforts to Avoid Contamination of Extraterrestrial Bodies

This month marks the first anniversary of man's initial step into space. On 4 October 1957, the Soviet Union, acting as a participant in the International Geophysical Year, placed the world's first artificial satellite into orbit. The repercussions of this launching and those that followed have been of the greatest significance in international relations, in education, and in science. A major scientific problem that came into being with the first satellite is that concerned with the contamination of celestial bodies by exploratory devices sent from the earth. It can be assumed that these bodies will be reached in the course of time. The problem that world scientists face is this: how to explore, and yet preserve for study, the physical and chemical structures that obtain on the moon, in the first case, and, eventually, on the other celestial bodies.

NAS Resolution

The first major scientific body to give thought to this problem was the National Academy of Sciences of the United States. On 8 February 1958 the Council of the Academy adopted the following resolution:

The launching of IGY satellites has opened space to exploration. Accordingly, attempts to reach the moon and planets can be anticipated, with reasonable confidence, within the foreseeable future.

The National Academy of Sciences of the United States of America urges that scientists plan lunar and planetary studies with great care and deep concern so that initial operations do not compromise and make impossible forever after critical scientific experiments. For example, biological or radioactive contamination of extraterrestrial objects could easily occur unless initial space activities be carefully planned and conducted with extreme care.

The National Academy of Sciences will endeavor to plan lunar or planetary experiments in which the Academy participates so as to prevent contamination of celestial objects in a way that would impair the unique and powerful scientific opportunities that might be realized in subsequent scientific exploration.

The Council of the National Academy of Sciences of the United States of America urges the Internaitonal Council of Scientific Unions to encourage and assist the evaluation of possibilities of such contamination and the development of means for its prevention. The Council of the Academy also requests the International Council of Scientific Unions to do whatever else it may to preserve and foster the unaffected potentialities of space research.

Committee on Contamination by Extraterrestrial Exploration

The International Council of Scientific Unions responded to the Academy of Sciences' request by establishing a Committee on Contamination by Extraterrestrial Exploration. This group, also known as CETEX, met at The Hague 12–13 May 1958, with the following scientists as participants: Marcel Florkin, president; J. Rösch, of the International Astronomical Union; P. Alexander, of the International Union of Biological Sciences; Donald J. Hughes, of the International Union of Pure and Applied Physics. M. Nicolet, of the Special Committee for the International Geophysical Year, and P. Swings, of the International Astronautical Federation Exploratory Committee of the International Council of Scientific Unions, were observers.

The committee considered the problem brought up by the National Academy, and issued the following summary record of the meeting, which is, in effect, a fact sheet on the problem.

The moon's atmosphere. The moon's atmosphere contains only a small amount of matter (estimates range from 10 to 100 tons) and is therefore extremely vulnerable to contamination. The release on the surface of any amount of volatile material within this range of magnitude such as might be given off from explosions of TNT for marking purposes is likely to alter the atmosphere for very long periods as it will probably take some years for the products to escape from the moon's atmosphere. Another factor which a change in the lunar atmosphere might bring about is an upset in the thermal equilibrium and careful computation will be required before the magnitude of this effect can be assessed. The possibility that the impact of a rocket vehicle may already be sufficient to alter the atmosphere by releasing trapped gases was rejected because the moon's surface must occasionally be subject to bombardment by heavy meteorites.

The release of any chemical marker on the moon's surface is therefore objectionable if it involves tons of material, and if it has to be done, a flare releasing material quite unlike that normally present in the lunar atmosphere should be used so that in subsequent investigations it can be clearly recognized as a contaminant introduced by man. Both in this connection and because of increased ease in detection a flare produced by burning metallic sodium in chlorine or bromine should be considered. The sodium D lines could be detected at low intensities if a monochromator is used to cut out scattered light of other wavelengths. Probably the quantity of material required to be visible through a telescope, though not to the naked eye, would be insufficient to cause serious contamination of the atmosphere. Even so this type of flare cannot be accepted until the possibility has been ruled out that the ionization of the sodium atoms by releasing electrons would not disturb the "lunar ionosphere" which may be more susceptible than the lunar atmosphere.

Finally the moon's atmosphere will almost certainly be spoilt once measuring instruments are landed, since this requires deceleration which in the present state of the art would involve the release of chemical propellants in ton amounts.

From the foregoing it is clear that detailed exploration can very easily spoil the lunar atmosphere which should, if at all possible, be studied in the initial phases by objects which circuit the moon. Priority should be given to such studies and the committee urges that no flares be lit until information about the atmosphere has been obtained, or until it has been shown that an orbit sufficiently close to the moon cannot be attained. An accidental hit by a vehicle which has failed to orbit would probably not be serious, since the moon's surface must occasionally be subject to bombardment by heavy meteorites and the release of trapped gases by impact will not therefore cause a departure from natural conditions.

Moon dust. The chemical composition of the dust on the moon's surface is of

the greatest interest to a wide range of sciences. Knowledge of changes of composition at different levels would also be informative but may be impossible to obtain since bombardment by meteorites is likely to keep the dust mixed. Disturbance of the dust by rocket impact is unlikely to be harmful, as in view of the low density of the lunar atmosphere the disturbed dust particles will fall out locally and not travel all over the moon. For the same reason any contamination of the dust by space operations will be localized and will not prejudice future analytical work (but see the section "Development of complex molecules" below), so long as no fusion or fission explosions are carried out.

The only serious danger of spoiling the moon's dust will come from nuclear explosions. These will release volatile fission products (in the extreme vacuum of the moon even elements like strontium are likely to behave as gases) which will enter the moon's atmosphere and will be rapidly distributed by diffusion. These radioactive atoms will be in a highly reactive form and on coming into contact with moon dust may form involatile compounds. In this way the whole surface of the moon may acquire additional radioactivity which may interfere with subsequent radiochemical analyses that could be of the greatest value in particular for problems relating to the past history of the moon.

In this respect the explosion of a fusion device is likely to be more serious than that of a fission bomb since the former will give rise exclusively to volatile radioactive products, notably tritium, whereas the bulk of the volatile fission products are rare gases which will not combine with the moon dust. However the range of the small particles by which fission bomb activity is spread is likely to be very great on the moon and a serious danger of contamination would undoubtedly arise.

Cosmic dust. The possibility that valuable information concerning cosmic (i.e., interstellar and interplanetary) dust may be lost by disturbing the moon's surface has been considered but is unlikely to be serious. This interesting material is known to consist largely of low atomic number elements such as hydrogen, carbon, nitrogen and oxygen and many of the corresponding molecules will be volatilized by solar radiation. Hence only residues of high atomic elements will remain on the moon and this material is no more informative than similar deposits of interplanetary material which can be found at the bottom of the oceans.

Panspermia hypothesis. The suggestion that moon dust might help in evaluating the hypothesis that dissemination of life in the cosmos occurred by transport of forms of life in the cosmic dust must be rejected for the same reason as that given in the section on "Cosmic dust" above—namely that solar radiation (in high vacuum) would decompose "biospores" just as it decomposes cosmic dust. Contamination by organic or living matter would therefore not be harmful in this connection although it must be avoided for another reason (see below).

Contamination of the moon by living cells. There is no possibility that the introduction of cells such as spores or bacteria might give rise to life on the moon of the same type (i.e., containing deoxyribonucleic acid) as on earth which might confuse later investigators. There are no cells on earth which grow or multiply in the absence of water and at the high vacuum of the moon no water can exist.

Development of complex molecules. The basic problem concerning the origin of life is how complex molecules (on the earth they are based on carbon) came to be built up and become replicated. It is conceivable that the interior of the moon dust may provide some valuable clues in this direction. It is not beyond the bounds of possibility that some "prelife" processes may be occurring on the moon and these may be similar to or different from those which had taken place on earth. If there are such processes then the introduction of "foreign" macromolecules from the earth may cause a serious upset in the lunar processes. The earth macromolecules may under lunar conditions act as templates and provide new foci for "prelife" growth. If such events were started indiscriminately all over the moon the pattern might be distorted. It is important to emphasize that living cells are not envisaged for this process and that in this connection a dead bacterium from an aseptic rocket would be as harmful as a live one. Admittedly the occurrence of any such growth reactions is remote but the problem is so important that we recommend that a simple precaution against endangering future studies is to limit the areas of landings on the moon and thereby to localize the effects—if any—of terrestrial templates.

Contamination of Mars and Venus. The problems of reaching the planets are of the same kind as those involved in lunar exploration and objects will no doubt be sent there relatively quickly after the moon has been reached initially by circumnavigation, if our findings under the section "The moon's atmosphere" above are heeded. The danger of contamination of these planets is mainly biological since there is a reasonable probability that the conditions on Mars are such that some terrestrial organisms might grow. Water, nitrogen, carbon oxides and light for photosynthesis are all available.

It is therefore of the greatest importance that space vehicles should not land either accidentally or deliberately on Mars (and possibly also Venus) unless all precautions have been taken to exclude living organisms from them. Otherwise the most challenging of all planetary studies, that of extraterrestrial life, may be put in jeopardy. The same precautions in regard to the development of complex molecules which have been dealt with in respect to lunar contamination in the paragraph above apply equally to both Mars and Venus.

Although the relative extent of the contamination from a nuclear explosion would be very much smaller than in the case of the moon it may nonetheless be sufficient to interfere with detailed radiochemical analyses under certain conditions. Also the effect of introducing radioactivity on another planet where there may be entirely differetnt levels of background radiation from those found on earth could greatly influence any form of life found there. Although the objections against nuclear explosions on Mars and Venus may not be as compelling as in the case of the moon, they are nevertheless well justified until more information is available.

Recommendations

During the first days of this month the eighth General Assembly of the International Council of Scientific Unions met in Washington, D.C. Under its aegis, the recommendations of the CETEX members were made public. They are as follows:

CETEX believes that there is a real danger that exploration attempts made within the next few years may produce contamination of extraterrestrial bodies which would complicate or render impossible more detailed studies, when the technological problems of landing sensitive scientific instruments on the moon and planets have been solved.

CETEX is only concerned with genuine exploration intended to provide bona fide scientific data. Here there may be a conflict, because an experiment essential for one purpose may make it impossible for other types of studies to be made subsequently (e.g., the explosion of a nuclear device to provide seismic data on the interior of the moon or of the planets might make subsequent radiochemical analysis meaningless).

CETEX has considered various dangers of contamination in outline, but did not have at its disposal sufficient scientific and technological data to enable it to propose a specific code of conduct, which should achieve a reasonable compromise between the perfectly proper ambition to start lunar—and possible planetary—exploration at the earliest moment and the need to safeguard future research.

CETEX feels that such a code of conduct must be drafted with the minimum

of delay. It proposes to the ICSU that interested and expert parties be asked by the national members of ICSU to prepare detailed papers bearing on the topics raised in this initial report; and that thereafter these papers be made available to it for a second meeting before the end of 1958, at which detailed recommendations can be prepared with the aid of advisory experts.

Nuclear Explosion Detector

During this month a new type of seismograph, believed to be capable of detecting nuclear blasts anywhere in the world, will receive intensive tests to determine its effectiveness. The device is the long-period seismograph, capable of recording shock waves with an interval, or period, of a minute or more.

An effort is being made to install as many of the new instruments as possible before the completion of the current series of nuclear tests in Nevada, 31 Oct. To aid in the testing of the new device, the Atomic Energy Commission has announced the precise times and locations of 15 nuclear explosions. Of ten set off in the Marshall Islands in 1954 and 1956, nine were visible on recordings made at the Lamont Observatory. Of five shots in Nevada last year, three were recorded.

Scientists from East and West, meeting in Geneva, recently agreed that long-range detection of nuclear blasts was feasible. The long-period seismograph may prove to be one of the favored devices for an international monitoring system. The United States has announced it is willing to suspend tests on 31 Oct., provided other powers suspend theirs.

Multiple Birth Roster

The New York City Department of Health has established a "Multiple Birth Roster." The roster is intended to be a source of information for research workers in genetics, child development, and other fields. The department will cooperate with researchers to supply them with some data which may be helpful to them to initiate genetic studies.

All multiple births involving at least two live infants are included in the roster. All the identifying, demographic, and pregnancy information available on the birth certificate of each infant is punched on a tabulating card. A photostatic copy of the complete record of birth is also in the register, so that details not available on the punched card may be conveniently abstracted. The roster will be kept up-to-date in three respects: adoption of a child, death during the first year of life, and data fed back to the roster by the individual researcher. The roster was initiated as of 1 January 1958 and will be continued indefinitely. At a later date an evaluation will be made to determine whether its usage by researchers warrants its continuation.

Researchers requesting information from the roster will be expected to adhere to such requirements as the department may deem necessary. All requests will be reviewed as to the qualifications of the investigator and the value of the proposed study. Investigators may be asked to allocate clerical staff to assist in selecting the data requested. Facts elicited by home interviews or abstract of records, or both, are to be made available by the researcher to other researchers to avoid duplication of effort.

Formal requests should be submitted to Dr. Harold Jacobziner, Assistant Commissioner for Maternal and Child Health Services, New York City Department of Health, 125 Worth Street, New York 13.

Princeton Archeologists

A team of archeologists from Princeton University has exhumed a large treasure of artifacts in the Serra Orlando region of Sicily. The team, working for the past four summers near the town of Aidone, has found a number of life-sized human busts, pieces of pottery, a stone offertory box, and many terra cotta figures. Some of the objects date from the sixth century B.C.

Aidone, once a fortified inland Greek settlement known as Morgantina, flourished from 600 to 20 B.C., when it disappeared from the pages of recorded history.

The archeological team's prize discovery, a red figured wine and water vessel, was reconstructed from many shards. Pieced together, it is about 16½ inches in diameter and has a neck decorated with a combat scene between Hercules and the Amazons and a depiction of a symposium.

The excavating project, which is supported by funds from the Bollingen Foundation, the university, and several Princeton alumni, will be resumed next spring.

NASA Receives Assignments

The new Aeronautics and Space Administration has been assigned a number of projects heretofore controlled by the Department of Defense. For the time being the shift of control will be mainly administrative, with the Defense Department continuing to operate the programs. The programs involved are Project Vanguard, the program for four lunar probes of the Advanced Research Projects Agency, three satellite projects, also formerly under ARPA, and a number of Air Force research projects concerned with nuclear rocket engines, fluorine engines, and a 1-million-pound-thrust, single-chamber engine.

NASA will have control over all space projects that are not primarily military in nature. Funds for nonmilitary projects that had been under the Defense Department have been transferred to the new agency.

Proposals for International Atomic Energy Agency

An international research program on the peaceful uses of atomic energy, to be supported by the United States, was suggested last month by the chairman of the Atomic Energy Commission. At an international atomic agency conference in Vienna, John A. McCone, of the U.S. Atomic Energy Commission, said that under the program, if it is accepted, the United States would assign specific research projects to the agency. In turn, the agency would hand the projects out on a contract basis to scientific teams throughout the world. Addressing the conference of 400 delegates, McCone said: "My government believes that there exists throughout the world today a wealth of scientific and technical competence which is not being brought fully to bear on the development of the peaceful uses of atomic energy."

News Briefs

The violent hurricane Helene which hit the North Carolina coast last month carried a balloon-borne radio beacon in its eye for some part of its sweep toward the coast. The beacon, devised by the Weather Bureau for more accurate tracking of such storms, was dropped from an Air Force B-50. It was a test device which carried batteries good for only 24 hours. Signals were heard for at least 2 hours after the drop by a monitoring aircraft.

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On 26 September the Navy fired a full-sized 20-inch Vanguard satellite into space, but a failure, suspected to have occurred in a directional gear box, kept it from going into orbit. It was the seventh launching in the Vanguard program, and the sixth failure. The satellite, weighing 22 pounds, contained a scanning device to measure the distribution of clouds covering the earth.

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It was reported at the Air Force Association's Dallas meeting last month that the Air Force's Thor, an intermediate range ballistic missile, has been selected over the Army's Jupiter to be this country's mass-produced IRBM weapon. It was said that a decision had been reached