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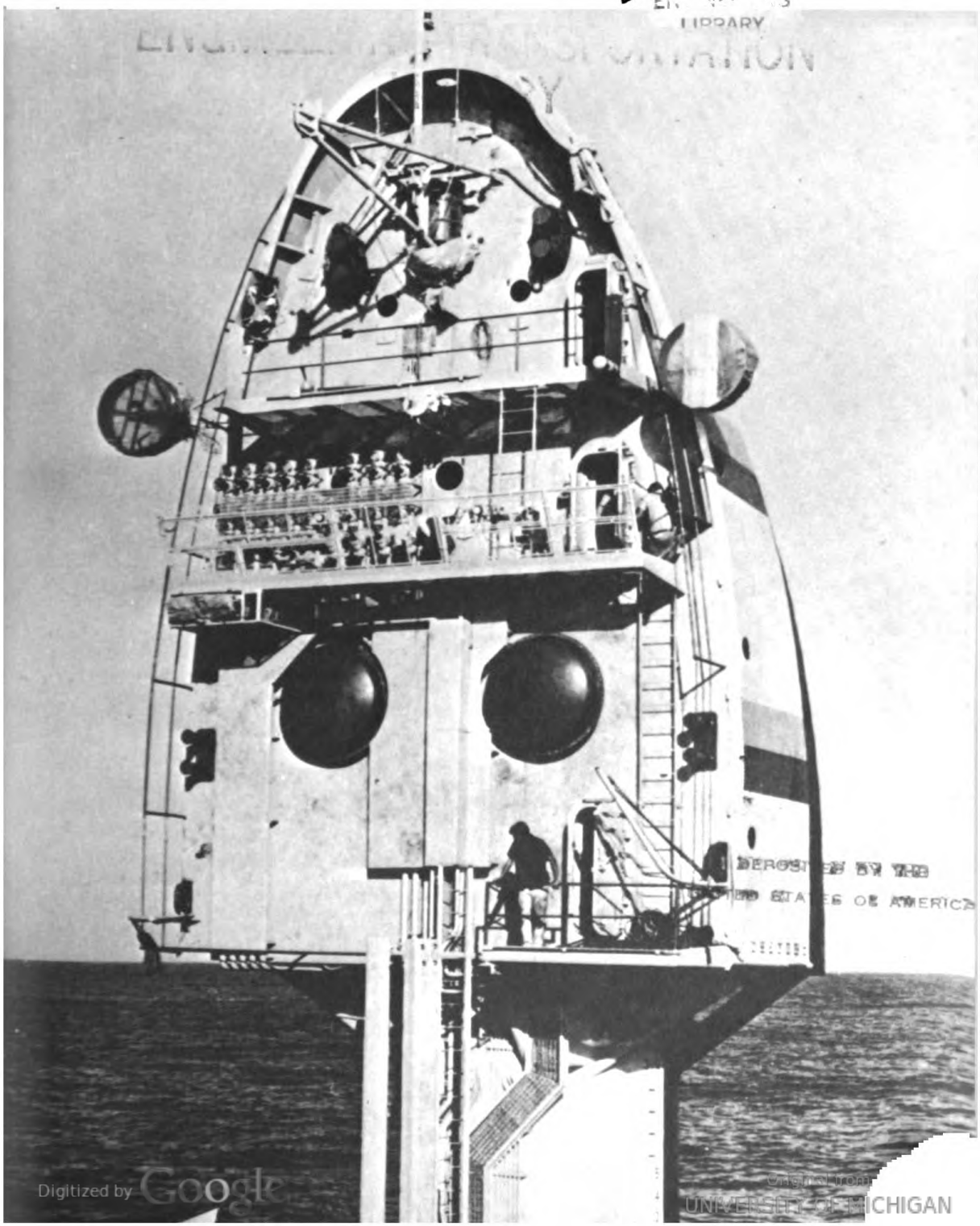
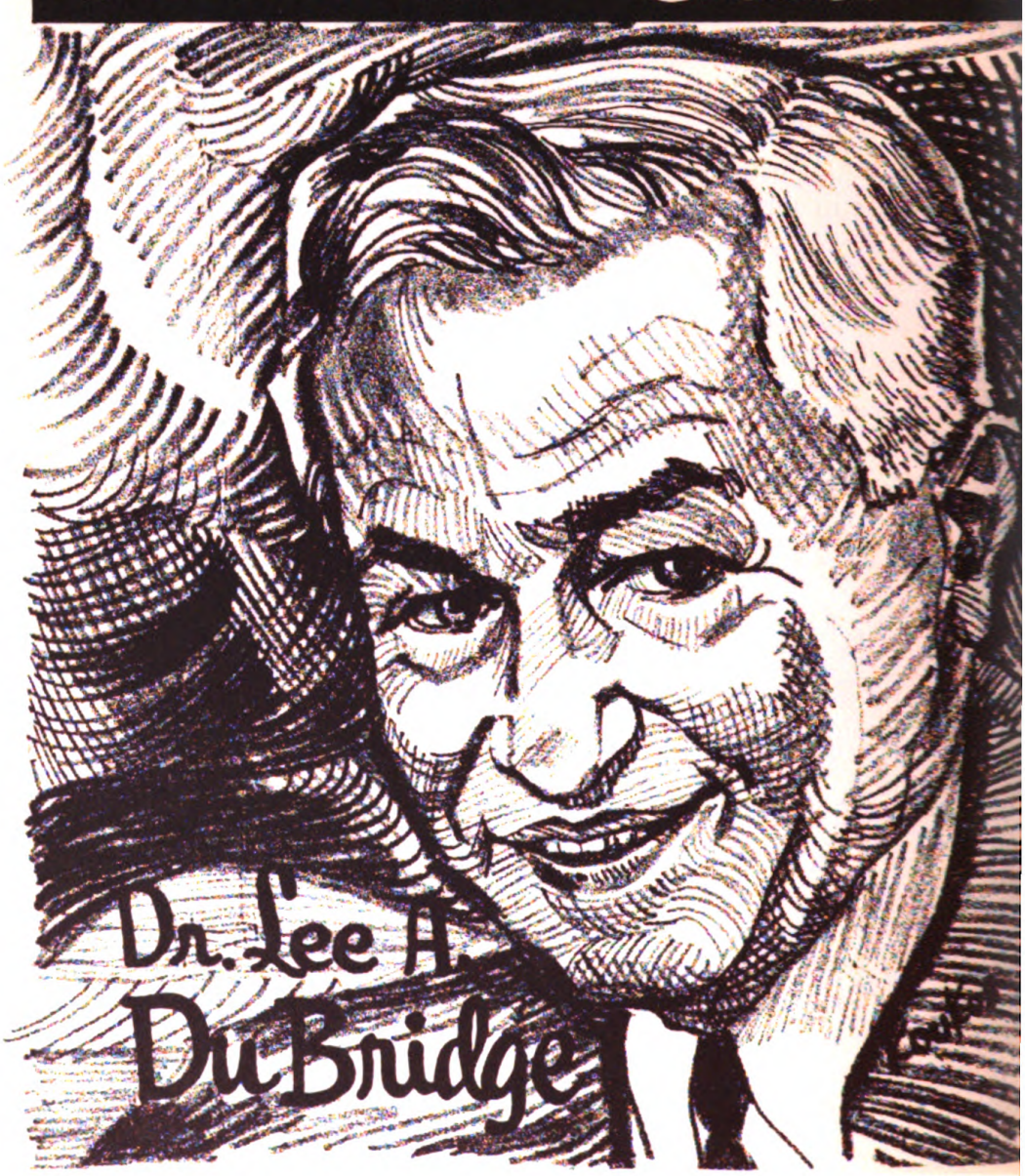


Portraits in Science



IN 1951 PRESIDENT TRUMAN APPOINTED DuBRIDGE TO THE GOVERNMENT'S NEW SCIENCE ADVISORY COMMITTEE, ESTABLISHED TO MAINTAIN CONTACT BETWEEN THE FEDERAL GOVERNMENT AND THE SCIENTIFIC COMMUNITY. THE NEXT YEAR PRESIDENT EISENHOWER ASKED DuBRIDGE TO BECOME CHAIRMAN OF THAT COMMITTEE, A JOB HE HELD UNTIL 1958. TWO ADMINISTRATIONS LATER, PRESIDENT NIXON APPOINTED DuBRIDGE HIS SPECIAL ASSISTANT FOR SCIENCE AND TECHNOLOGY.

DuBRIDGE RECEIVED HIS PH. D. AT THE UNIVERSITY OF WISCONSIN, SERVED AT WASHINGTON UNIVERSITY, ST. LOUIS, AND NEXT HEADED THE PHYSICS DEPARTMENT AT THE UNIVERSITY OF ROCHESTER. DuBRIDGE IS NOTED FOR HIS WORK ON THE PHOTOELECTRIC EFFECT AND ON P-N REACTIONS. DURING WORLD WAR II DuBRIDGE WAS DIRECTOR OF THE RADIATION LABORATORY (RADAR RESEARCH) AT M. I. T. IN 1946 HE BECAME PRESIDENT OF CALIFORNIA INSTITUTE OF TECHNOLOGY, WHICH POST HE HELD UNTIL BECOMING AN ASSISTANT TO PRESIDENT NIXON.

DURING DuBRIDGE'S PRESIDENCY, CALIFORNIA INSTITUTE OF TECHNOLOGY BECAME ONE OF ONR'S MAJOR CONTRACTORS.

Copyright, Fair Use and the Navy Scientist

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"Research," according to one copyright lawyer's cynical observation, "is plagiarism from more then a single source." However, plagiarism in the narrow sense poses no problem to the serious researcher. The question of copyright infringement is not so easily resolved. Whether it is permissible to incorporate, with proper credit, a figure or a table from a copyrighted source is a question sometimes faced by scientists about to publish the results of their research. Usually a copyright proprietor will grant gratuitous permission to include short abstracts from his copyrighted work. But in the rush to publication, time is of the essence. Requesting and receiving permission involves time, in many cases too much time, so that the abstract may be included without permission or omitted.

Since section 1498(b) of Title 28 of the United States Code provides a remedy to an aggrieved copyright owner for infringement by the Government, the question of copyright infringement is of concern throughout the Navy. The statute implicitly clarifies the position of an employee who infringes a copyright in the course of his duties; he cannot be held personally liable for such infringements. Prior to the addition of the portion of 28 U.S.C. 1498, in 1960, spelling out the Government's liability for copyright infringement, many believed that an employee could be held personally liable for any infringement committed during the course of his employment (1).

SecNav Instruction 5870.1A of 10 November 1965, provides policy guidance concerning the inclusion of copyrighted material in publications of the Navy. In addition, Navy Regulation 1265 states that no person in the Naval Establishment shall use any matter in which there is reason to believe a copyright exists without authorization by the Secretary of the Navy. The authority to authorize such use has been redelegated to the Chief of Naval Research.

Fair Use

Copyright in the United States consists of two varieties, the so called common law copyright and statutory copyright. Common law copyright exists in an author's unpublished work and subsists until publication. It may be thought of as a right of first publication in the owner which is extinguished by the fact of publication. Consequently, it

affords an author no protection against copying of his published work. Recognition of this undoubtedly led Noah Webster to persuade the legislature of Connecticut in 1783 to enact the first copyright statute in America to protect his spelling book against copying (2).

The present Federal copyright statute, Title 17 of the United States Code, affords the copyright proprietor certain rights among which is the "exclusive right to print, reprint, publish, copy and vend the copyrighted work." Section 10 provides that any person may secure copyright for his work by publication with notice of copyright as required by the statute. Publication without notice dedicates the work to the public so that a published work not bearing a copyright notice may be freely copied by all. This is of some significance to scientists because the journals of a number of scientific societies are not copyrighted. These journals may encourage certain forms of copying to achieve broader dissemination of information. Other journals copyright to prevent misuse of the material in the journal but not as a bar to dissemination (3).

The extent to which inclusion of copyrighted material in a publication is permissible under the doctrine of fair use is "based upon the principle that subsequent workers in the same field are not deprived of all use; otherwise, the progress of science and the useful arts would be unduly obstructed," (4). The question of fair use occurs frequently in dealing with scientific, technical and medical papers where the scientist wishes to make a copy for his personal use or where he desires to include an excerpt in his own publication. Fair use has been characterized as the most troublesome in the whole of copyright law (5). It is impossible to provide precise, general guidance for the interested scientist, librarian or copy machine operator. Probably for this reason, the concept of fair use is not discussed in SecNav Instruction 5870.1A. This paper will attempt to outline the nature of fair use as it applies specifically to two areas which most frequently arise within the Navy extracts from scientific journals and single copy duplication.

Extracts From Scientific Journals

Fair use has been defined as "a privilege in others than the owner of the copyright, to use the copyright material in a reasonable manner without his consent..." (6).

The key words in this definition are "in a reasonable manner." What is reasonable to the user may well seem unreasonable to the copyright owner. The general revision of the copyright law (H.R. 2512, of the 90th Congress) which has been approved by the House of Representatives contains a definition of fair use. The bill specifies the following factors to be considered in determining whether fair use exists:

- The purpose and character of the use,
- The nature of the copyrighted work,
- The amount in substantiality of the portion used in relation to the copyrighted work as a whole, and
- The effect of the use upon the potential market for or value of the copyrighted work.

Justice Story suggested the following criteria to determine whether the use made of the copyrighted work is fair:

> "...the nature and objects of the selection made, the quantity and value of the materials used, and the degree in which the use may prejudice the sale, or diminish the profit, or supersede the objects, of the original work" (7).

Criteria having more or fewer elements but involving similar ethical and economical considerations have been suggested (8).

The basis for the copyright law resides in Article I, Section 8 of the Constitution which empowers Congress "to promote the progress of science and the useful arts by securing for a limited time to authors and inventors the exclusive right to their respective writings and discoveries." The Supreme Court has construed this clause as both a grant of power and a limitation so that no patent can be validly granted which does not promote the progress of the useful arts (9). By parity of reasoning, a valid copyright must also promote the progress of science. Any attempt by a copyright owner to extend his monopoly in a manner which would stifle such progress would not be tolerated by the courts. It is, therefore, not surprising that in the non-fiction area the scope of fair use finds its broadest range. The underlying philosophy for permitting this scope of fair use in factual works is well expressed in the Sampson & Murdock Case:

> So also, it is clear that, under some circumstances and for certain purposes, a subsequent publisher may draw from the earlier publication its identical words, and make use of them. This is peculiarly so with reference to work in the arts and sciences, using those words in the broadest sense, because, with reference to them, any publication is given out as a development in the way of progress, and, to a certain extent by common consent, including the implied consent of the first publisher, others interested in advancing the same art or science may commence where the prior author stopped. This includes medical and legal publications in which the entire community has an interest and which authors are supposed to give forth, not only for their own pecuniary profit but for the advancement of science. Therefore, as to copyrighted works of that character, by the common consent to which we have referred, subsequent authors are sometimes entitled and indeed required to

make use of what precedes them in the precise form in which it was last exhibited...(10).

In the case of such works, the courts often look for virtual identity of the portions of the copyrighted work forming the alleged source. It should be borne in mind that copyright conveys no monopoly of the information as opposed to the literary style (11). One court observed that to permit over-wide latitude of copyright protection for non-fiction works would lead to mischief "for then an accurate and comprehensive treatise on algebra, for instance, would, if copyrighted prevent another from later writing one as accurate and comprehensive during the copyright term" (12).

Where the subject matter is restrictive, there is even a reluctance to permit copyright of the particular mode of expression since this might effectively appropriate the subject matter to the author. In such narrow cases, the Court will not await an attempt by the author to copyright various forms of expressions of the uncopyrightable information. "We cannot recognize copyright as a game of chess in which the public can be checkmated...Rather, in these circumstances, we hold that copyright does not extend to the subject matter at all, and plaintiff cannot complain even if his particular expression was deliberately adopted" (13).

Thus, if the form of expression flows inevitably from the subject matter, it appears that it is permissible to restate the information conveyed in a copyrighted work such as by copying a mathematical equation, a chemical equation or other statement of fact (or hypothesis) capable of only one form of expression or at best a limited number of forms of expression.

In the case of Baker v. Selden (14) the Supreme Court had to determine whether Selden's copyright in a book explaining a type of double entry bookkeeping and illustrating the system with sample ledger forms was infringed by the defendant who incorporated the forms into ledger books for use by accountants. Noting that the defendant's work was a substantial copy of the plaintiff's it held that while no one could copy material portions of Selden's as a book intended to convey instruction in the art, the copyright could not secure the exclusive right to accounting forms prepared upon the plan set forth in his book.

The court noted that copyright of a work on mathematical science would not permit the author to prevent an engineer from using the diagrams employed to explain his methods; and if the art taught cannot be practiced without employing the methods and diagrams used to illustrate it, they are considered as necessary and given to the public for the purpose of practical application but not for the purpose of publication in other works explanatory of the art.

The doctrine of Baker v. Selden has been applied to situations where the plaintiff sought to establish that construction according to copyright plans was an infringement of his copyright (15).

While claims of copyright infringement occasionally subordinate the copyright holder's financial return to the development of science and industry, a user will not be permitted to extract portions of a copyrighted work for commercial gain. In the Holt case, (16) the defendant in an advertising pamphlet entitled, *Facts About Cigarettes* included a quote as follows:

> Dr. Leon Felderman, noted otolaryngologist, Philadelphia, is quoted (1931) as follows: "Statistics have it that 80 percent of physicians are smokers...It appears unanimous that smoking is not nearly so injurious as overeating...From my experience with ear, nose and throat cases, I firmly believe that tobacco, when properly used, has no ill effect upon the auditory passages."

The extract was from a book entitled *The Human Voice, Its Care and Development* written by Dr. Felderman. Dr. Felderman alleged that sale of his book had been impaired since it appeared that he had commercialized his scientific work. The fact that only three sentences were extracted and that proper credit was given to Dr. Felderman did not absolve the defendant. Publication in the advertising pamphlet was to advance the sale of Chesterfield cigarettes, and it could not be implied that Dr. Felderman consented to the use of his work for such a commercial purpose.

The fact that the portion copied constituted a small part of the original work did not aid the defendant since it was the portion of the original work which is pertinent to the subject. Both the definition of "fair use" of story and the definition of H.R. 2512 refer both to the quantity and the "substantiality" or "value" of the portion used. The question of infringement does not solely depend upon quantity. Copying of a small portion of the original work, which is a material and substantial part, is sufficient to take the use out of the realm of fair use as shown by the Holt case. This is especially true where the nature of the infringing use is purely commercial as opposed to scientific. The converse has been proposed by Judge Yankwich: "If the amount reproduced is a part of a scientific or other exposition of the subject in which theories expounded by others must be discussed, the use, *regardless of quantity,* is fair," (17).

If the quoted portion of the Felderman book had been included in a book review where the extract was legitimately necessary to properly review the book or if it had been included in a scientific book discussing Dr. Felderman's theory regarding the use of tobacco, then such use would undoubtedly have been fair use.

Even if the copying is in the scientific area, the principle of fair use will not apply where the copy diminishes the demand for the copyrighted work. No writer may copy substantial or material portions of another's writings to supplant the original or provide an alternate

source for the original thereby diminishing the demand for the source material (18).

The foregoing suggests that where the Navy author, in the preparation of a paper of a scientific or technical nature, must make reference to the work of others, he may include a short excerpt from a previous work of another if it is reasonably necessary as a starting point for further development of the subject matter in this paper.

Single Copy Duplication

If the number of inquiries to the Director of Navy Patents may serve as a reliable indication, considerations of copyright law frequently intrude into the conscience of the Navy scientists about to make a single quick copy of a professional journal article for his personal use.

Legal counsel in industry generally take the view that such "inhouse" use of copyrighted material is fair use (19). This may be open to serious question where the copying serves to diminish the demand for the original by supplanting multiple subscriptions with multiple in-house copying and internal distribution. The latter type of copying apparently does not arise frequently within the Navy perhaps because it is uneconomical for a library to duplicate many copies of articles and distribute them through the Navy rather than purchasing additional subscriptions for circulation. Single article copying must be understood to be limited for the purposes of this discussion to instances where a scientist desires a copy of a specific article for reference or other personal purposes. No case squarely on the point of single copy reproduction for personal use has been located. However, a review of other decides cases seems to confirm the observations that:

> "Throughout the cases dealing with fair use, one cannot help but feel that the thoughts of the Court are upon the use of the work for purposes of publication, performance, exhibition and the like without giving any consideration to situations which arise solely because the material is needed for private, scholarly research and no other use" (20).

One author states that libraries exist for the purpose of copying (21), another has taken the position that the making of a single copy for personal use violates no copyright and is a right of scholars (22). While these are broad statements, they appear to have some justification. The Joint Committee on Materials for Research and the Board of Directors of the National Association of Book Publishers agreed on the following statement (23):

> "The statutes make no specific provision for a right of a research worker to make copies by hand or by type script for his research notes, but a student has always been free to "copy by hand; and

mechanical reproductions from copyrighted material are presumably intended to take the place of hand transcriptions, and to be governed by the same principles governing hand transcriptions."

This statement on single copying is included in the so called gentlemen's agreement between the Book Publishers Bureau, Inc. and the Joint Committee on Reproduction of Materials for Research. It may be viewed a mutually acceptable statement of the practical scope of the doctrine of fair use as applied to documentary reproduction.

While the gentlemen's agreement does provide for the making of single copies for personal use of the subscriber by libraries on request, representatives of various library associations have raised several objections to the agreement (24). The most fundamental is that the agreement recognizes that the copying is at the sufferance of the copyright owner who apparently retains a right to forbid such copying. Furthermore, it imposes certain restrictions including the marking of reproduced copies which may prove burdensome to the libraries. Finally, not all book publishers subscribed to the agreement.

The late Arthur Fisher, recognizing perhaps that the current status of the law left the librarian and library associations somewhat uneasy about providing the single copies to its patrons, suggested that the basis for library photocopying might be found in the "law merchant" of library work. That is, in the acknowledged practice of making it possible for users to obtain materials in their collection (25). Inasmuch as several studies suggest that the making of a single copy for reference purposes does no harm to the copyright proprietor and in view of the fact that the making of a single copy for personal use has been recognized by man authors as a fair use, (26) the Director of Navy Patents has advised that it is not necessary to secure the consent of the copyright owner where a scientist requests permission to duplicate a copy of a journal article for his personal use, and that the library or reproduction service may provide him with a copy without infringing the right of the copyright proprietor.

Summary

The Navy author in the field of science or technology who publishes a paper which may find its way into the scientific community by free distribution, sales by the DDC–FCST complex, or *via* the Government Printing Office may quote from copyrighted journals and other scientific works of a copyrighted nature to the extent legitimately necessary. Nonetheless, it will probably continue to be the practice to request permission from the copyright owner to incorporate any portion of a copyrighted work in a report to be made publicly available. However, if the Navy could not obtain permission from the proprietor, the doctrine of fair use would be considered by the Assistant Chief of Naval

Research for Patents in granting permission under SecNav Instruction 5870.1A and Navy Regulation 1265.

No permission under Navy Regulation 1265 is required for the making of single copies of reference material for the personal use of the individual requiring it.

References

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13. Morrissey v. the Procter & Gamble Co. *et al,* 262 F. S. 737; 154 USPQ 193, 195 (C.A. 1st 1967)
14. 99 U.S. 101 (1878) 25 L. Ed. 841
15. Muller v Triborough Bridge Authority 43 F. Supp 298; 52 USPQ 227 (D.C. N.Y., 1942); DeSilva Construction Corp. v. Herrald *et al* 213 F. S. 184; 137 USPQ 96 (D.C. Fla., 1962) But see May *et al* v. Bray *et al* 30 COB 435 (S.D. Calif., 1955) unreported. See also Scholz Homes, Inc. v. Maddox *et al* 379 F. 2nd 84; 154 USPQ 197 (C.A. 6th, 1967) where the court declined, after a discussion of the authorities, to rule on the holding of the District Court that architectural plans are not infringed by copying solely for the purpose of assisting in the construction of a home in accordance with the plans.
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Water Surge from Arctic Basin to North Atlantic

Success of measurements of earth-heat flow at the bottom of the ocean depends to a large extent upon constancy of ocean-bottom temperatures over long term periods. Thermal transient effects in the mud fluctuating bottom temperatures can render steady earth-heat flow difficult or impossible to measure but can contain valuable hydrographic information not easily obtainable by standard oceanographic techniques. The long "memory of mud" for thermal events on the ocean bottom permits reconstruction of a synoptic picture for bottom events. Measurements made from drift station ARLIS-II in 1965, during its drift southward through the Greenland Sea, revealed a temperature disturbance in the mud of Denmark Strait corresponding to changes in ocean-bottom temperature of the order of 0.1°C occurring several hours to a month prior to the observations. The results suggest that a surge of cold (−0.45°C) bottom water, 100 km in horizontal extent, spilled over the Greenland-Iceland Ridge into the North Atlantic in April, 1965. Such surges on a time scale of hours to decades have been reported by various investigators who have suggested such fluctuations control the productivity of some of the world's largest fishing grounds and that they may play a role in climatic changes.

Details of these fluctuations and their controlling mechanisms are poorly understood because the difficulty of obtaining synoptic coverage by hydrographic observations. "Memory of the mud" provides a means of reconstructing the synoptic picture.

NMRI Staff Members Modify Must Unit for X-Ray Handling of Mass Casualties

The responsibility for the development of an x-ray facility, self-contained in a transportable shelter for rapid transfer to combat areas for handling mass casualties was assigned by BuMed to Navy Medical Research Institute (NMRI) staff members, Mr. Maynard Eicher, Head of the Instrumentation Laboratory, and LCDR James G. Garrick, MC, USNR, Clinical Investigation Department. To accomplish this task, an Army-designed MUST (Medical Unit, Self-Contained, Transportable) field hospital was modified for shipboard use and equipped with a field x-ray machine. For shipping, the unit folds compactly, can be moved by a fork lift, and air lifted as cargo by a helicopter or other air craft. On location, it can be expanded and be in operation within three hours after arrival. It is equipped to process exposed films up to 14 in. × 17 in. immediately with drying in a three-minute automatic processor, and is adequate for rapid diagnostic films of litter patients.

A feasibility study is currently being conducted aboard the aircraft carrier, the USS GUAM (LPH-9) in collaboration with the Naval Amphibious Base, Little Creek, Va. HM1 Joseph Ewell, USN, Clinical Investigation Department, is conducting shipboard field tests and evaluation.

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Navy's Role in BOMEX

BOMEX Objectives

The Barbados Oceanographic and Meteorological Experiment (BOMEX) is a large-scale air-sea-interaction field experiment scheduled to be conducted in the vicinity of the island of Barbados in late spring and early summer 1969. This coordinated experiment will draw upon the talents and resources of federal agencies and academic institutions to conduct a concentrated environmental study of the ocean and atmosphere in an area of approximately a five-degree square of latitude and longitude located about 100 kilometers east of Barbados (Figure 1).

The primary objectives of BOMEX are to study the total ocean-atmosphere system within a limited oceanic area having known, representative, and conservative characteristics, and also to develop a pilot field study that may be used for planning and executing similar experiments in the future within the framework of the long-range Global Atmospheric Research Program (GARP) of the 1970's. The air-sea-interaction objectives of the experiment are:

- Study of the vertical flux of momentum, sensible heat, latent heat, radioactivity and other properties at the interface and the horizontal transport of these properties through the lateral boundaries of the observational array.
- Study of the vertical and horizontal divergence of these fluxes within the interior of each fluid.
- Study of the feasibility of parameterizing the area wide integral of a least the surface fluxes from conventional observation at the fixed corners of the array.

Related studies in physical oceanography and micro- and meso-scale meteorology also are to be undertaken. BOMEX will provide an excellent opportunity to conduct related experiments within a well-controlled observational network. This coordinated experiment is due to the fact that no single agency possesses the material resources and scientific manpower required to execute a study of atmospheric-ocean interaction processes simultaneously on the micro-, meso-, and synoptic scales. Such experiments are required for substantial advances in worldwide weather and oceanographic forecasting.

The BOMEX experiment is concerned primarily with the study of air-sea interaction. The principal interest of the Navy in this connection lies in the zone between the base of the thermocline and the gradient wind level. Atmospheric effects have a major role in modifying the environment in this zone. These environmental effects, which include currents, thermal structure, and sea state, impose vital constraints on the performance of weapon systems, detection devices, and naval

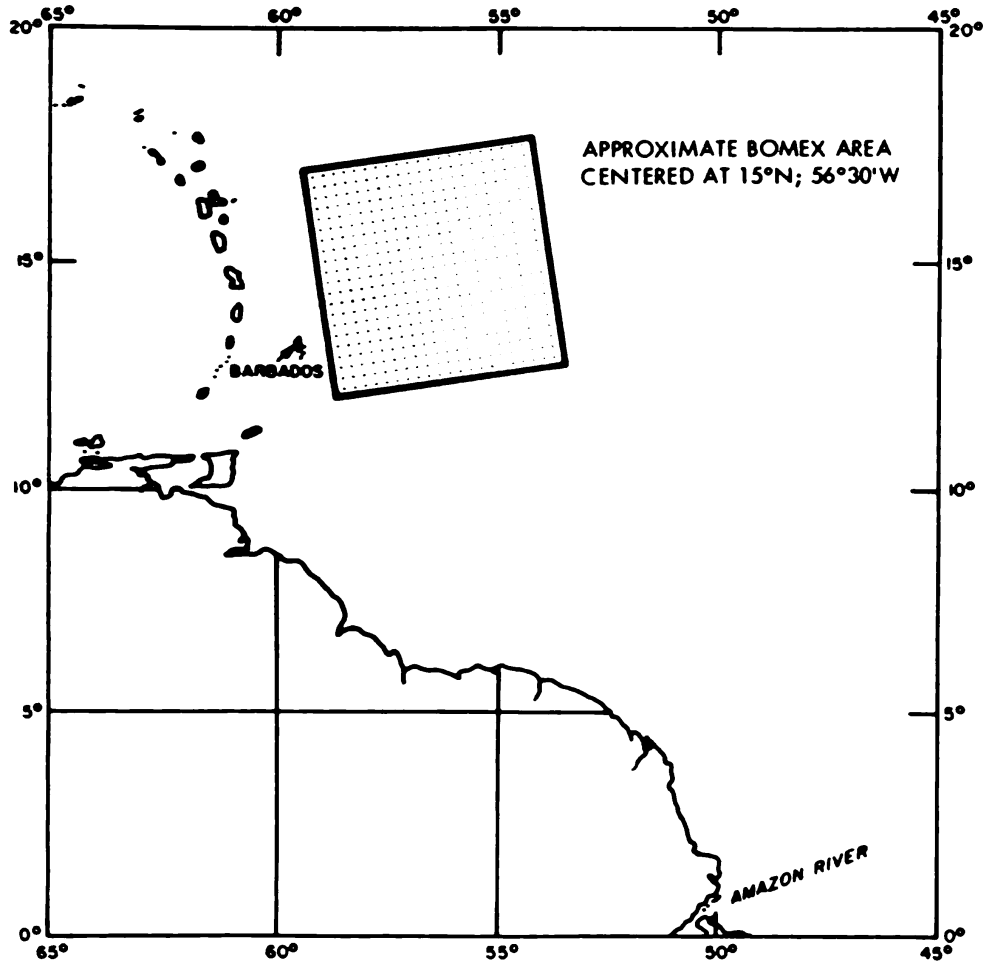


Figure 1 — Geographic limits of BOMEX area

platforms. The study of air-sea interaction has developed to a point where massive synoptic experiments are required to improve our ability to predict "undersea weather." This ability is essential to support the improvement and use of naval systems. The resource requirements for this type of experiment cannot be met easily by any one federal agency. Inasmuch as environmental information is needed for the missions of most of the agencies involved in marine activity, the BOMEX experiment is almost ideal for interagency cooperation.

General Description of the BOMEX Site

The site selected for this intensive study is in a region where energy exchange between the atmosphere and the ocean is particularly significant. The region is a sink for solar radiation reaching the earth's surface. The ocean acts as a reservoir which supplies large amounts of energy in the form of latent heat to the atmosphere. The winds in the Barbados area are governed by the general North Atlantic circulation pattern,

which undergoes marked seasonal changes. In winter (November through January), the Bermuda-Azores high moves to its northernmost position, and the winds are generally from the northeast. As summer approaches, the winds gradually shift to the east and increase in speed. The southernmost portion of the area to be studied is distinguished by periodic interruptions of wave-like atmospheric perturbations (easterly waves), which move westward at speeds up to 6 meters per second. During early summer when BOMEX is scheduled, few fully developed storms transit the area, and the likelihood of the experiment being disrupted from this cause is minimal.

The BOMEX area, is centered over the Guiana Basin, where maximum water depths are about 2900 fathoms. The southeastern part is uniformly deep and the ocean floor has topographic characteristics of an abyssal plain. The western part of the area overlies the rise and slope provinces seaward of the Lesser Antilles Arc. A low-relief, rise-like feature extends east southeastward into the northern part of the area.

Surface currents in the area generally set west to northwest throughout the year at mean speeds of about 0.7 knot (35 cm/sec). A series of subsurface current measurements obtained over a 24-day period in September and October 1967 indicates a westward flow with speeds of 15 to 20 cm/sec at 120 meters depth, northwesterly flow with speed of 2 to 3 cm/sec at 1500 meters depth, and easterly flow with speeds of 7 cm/sec at 4500 meters depth.

Organization of BOMEX

The overall coordination for BOMEX is the responsibility of the Department of Commerce. A BOMEX Project Office has been established within the Office of World Weather Systems in the Environmental Science Services Administration. It serves as a focus for planning and coordinating the experiment. The National Academy of Sciences also provides guidance to the Project Office through an advisory panel under the chairmanship of Dr. Robert Fleagle, University of Washington.

Several federal agencies are developing their projects for BOMEX: the Atomic Energy Commission, Department of Interior, National Aeronautics and Space Administration, National Science Foundation, Department of Transportation, National Oceanographic Data Center, Department of Defense. The agencies in turn are being coordinated with the Project Office for an integrated program. The Director of the Maury Center for Ocean Sciences, Dr. J. B. Hersey, has the responsibility for developing the plan for Navy participation in BOMEX involving both in-house and contractor elements of the Navy's Ocean Science and Technology programs.

Programs

The Navy participation in BOMEX will include both in-house and contractor programs. Navy programs will emphasize the study of the general problem of the temporal variability of the oceans. Recent advances in theoretical research and measurement technology have shown that the ocean, at all levels, is more restless than had previously been evident from interpretation of classical oceanographic observations. This restlessness is the result of external and internal processes acting to change the thermal fields, the fields of chemical properties, and the fields of motion.

Participation is being sponsored by the Office of Naval Research Contract research program, the Naval Research Laboratory, the Naval Oceanographic Office, the Naval Underwater Weapons Center of the Naval Ship Systems Command, and the Naval Underwater Weapons Research and Engineering Station of the Naval Ordnance Systems Command. The U.S. Navy Maury Center for Ocean Science has the overall responsibility for developing the Navy plan and coordinating with the BOMEX Project Office of the Environmental Science Services Administration.

It is the goal of the Navy programs to enhance the understanding of basic processes in low latitudes, such as the occurrence of internal gravity waves, tidal oscillations, and inertial oscillations and their relative energy levels; the turbulent fluxes of momentum, heat, and dissolved substances in the near-surface region of the ocean; and the characteristics of ocean currents at all depths.

The specific scientific areas with which the Navy programs will be concerned are as follows:

- Thermal structure
- Microscale energy processes
- Surface-wave generation
- Current-structure variability
- Environmental-prediction evaluation

Thermal Structure—For years the Navy has maintained research programs aimed at documenting and rationalizing the ocean thermal structure from microscopic to planetary scales. This interest in thermal structure results from the fact that temperature is the principal time-dependent, controlling factor in the propagation of sound in the ocean. Underwater sound is the Navy's primary energy form in weapons-system control, surveillance, and object location. The ocean, far from being the stylized medium of the classical acoustics textbook, is a restless, nonuniform fluid medium whose characteristics result in a wide spectrum of acoustic propagation anomalies ranging from large-scale horizontal and vertical refraction to subtle but important small-scale turbulent effects causing signal degradation or enhancement. It is

anticipated that the thermal-structure research program proposed as a cooperative effort in BOMEX will provide new insights into the controls on, the ocean's response to, and ultimate distribution of thermal energy incident at the air-sea boundary.

Microscale Energy Processes—The ocean receives solar energy in excess in the tropical regions, and releases it near the poles. The earth's rotation, tidal effects, and boundary effects perturb orderly flow, and introduce complexity. Finally small-scale phenomena becomes significant because they may be present over large areas, and thus disrupt still further the theoretical picture of energy exchange. Darkness, cloudiness, water transparency, thin surface films, bubbles from "white caps," evaporation, and stability all play a role in the energy budget.

As a consequence we observe a complex sequence of processes of energy transfer. In attempting to arrive at an understanding of these processes at the high frequencies, Navy investigators have designed and developed a number of sophisticated acoustic, thermal, and mechanical sensing techniques, and two virtually stable platforms which can be deployed into the ocean to serve as measurement platforms. The Maury Center for Ocean Science has arranged for one of these, FLIP, which is a huge cylindrical structure constructed under an ONR contract. FLIP is so designed that it can be towed to sea in a horizontal position and then upended by flooding ballast tanks in the stern. This procedure takes about 15 minutes. The portion of the buoy that remains above the water contains laboratories, living quarters, and engineering space. When it is time to return to home port, the vessel is "flipped" back to its horizontal position by blowing water from the ballast tanks with compressed air. Its crew of six are by necessity extremely versatile and all are capable of making the flipping operation alone with the exception of the cook. FLIP can accomodate nine scientist in addition to the crew members. This unique floating laboratory (Figure 2) will be deployed into the BOMEX area to serve as a measurement platform for the purpose of studying microscale energy processes. These measurements will include wind-stress measurements by hot wire, sonic and mechanical anemometry, providing opportunity, among other things, to compare distinct approaches to the estimation of this important oceanographic parameter. At the same time, the measurements of horixontal and vertical turbulent kinetic energy will be attempted in the near-surface layer of the ocean using fast-response thermal and mechanical instrumentation. It is anticipated that the microscale energy-transfer research program will provide better estimates of turbulent energy flux through the ocean surface and the upper layers of the ocean than heretofore available.

Surface-Wave Generation—Winds blowing over the water generate waves, and it seems a remarkable fact that the actual mechanism is still

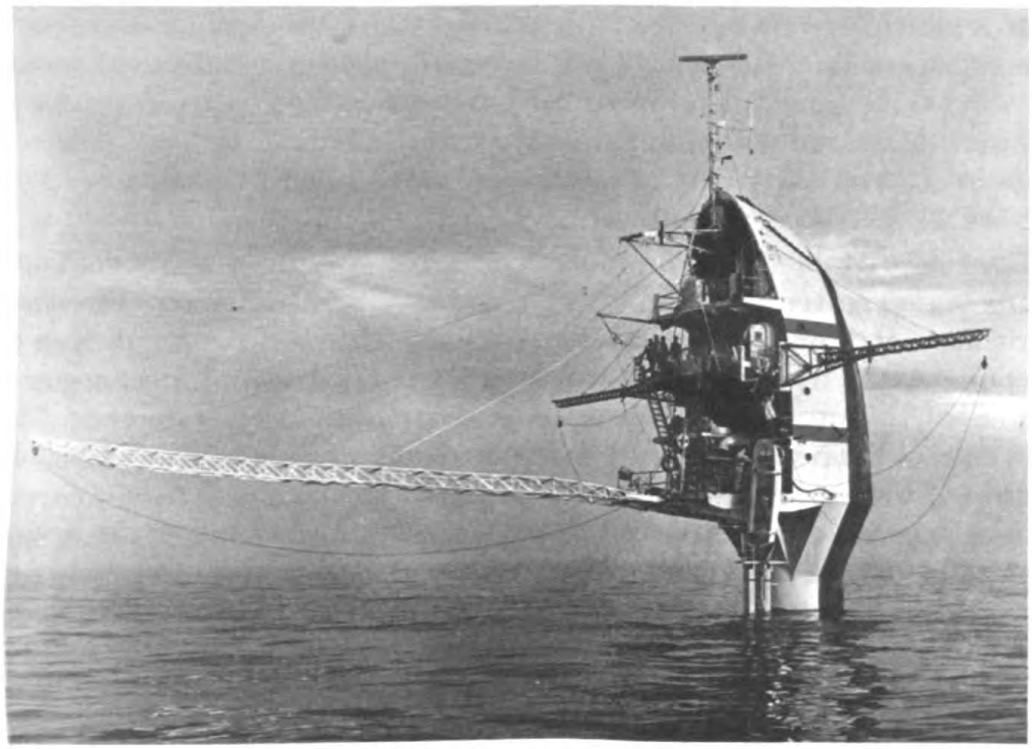


Figure 2 — Floating Instrument Platform (FLIP). In the vertical position shown, its draft is 300 feet.

unknown. Several promising theoretical approaches have been proposed in the past few years, attempting to provide a link between the driving force (the turbulent atmosphere above) and the response function (the moving sea-surface boundary below) which we call waves. Quantitative verification of the wave-making process is still obscure, partly because of the extreme difficulty involved in setting up controlled experiments. Occasionally, just the right conditions occur to permit execution of semicontrolled experiments. These experiments are being done as part of the Navy's in-house and contract research programs, but they do not have the extensive deep-water supporting data available that BOMEX will provide.

The persistence and steadiness of the trade-wind regime in the BOMEX area provides acceptable experimental conditions for investigating the spectral properties of wind-generated waves. On the windward side of Barbados, verification of the concept of a "steady-state" or "fully developed" sea can be checked; on the leeward side, well-documented sequences of limited fetch observations can be obtained. Now these wave data, characterized by as close to laboratory-controlled conditions as possible in the natural environment, can be obtained by radar wave-profiling capability aboard Navy aircraft. Additionally, a method recently developed by the Naval Research Laboratory for estimating directional wave spectra through optical transforms of sea-surface photographs will be tested.

It is anticipated that the research programs on surface-wave generation will provide a substantial gain in our understanding of processes of wind-wave generation, by virtue of the new and unique wave-measuring techniques and the multiplicity of auxiliary meteorological and air-sea-boundary data of research which will be obtained in the BOMEX.

Current-Structure Variability—Current measurements obtained from many sources over the past few years have emphasized the extreme variability and time-dependent nature of fluid flow at all scales of motion. After many years of relying on traditional oceanographic studies of large-scale distribution of current averages, it is now realized that little additional progress will be made unless we can identify the nature of the motion at all scales. Energy to drive these motions comes from large-scale atmospheric motions, large-surface heat sources and sinks, tidal effects, and other sources with various ranges of influence. The vertical stability of the ocean partially controls internal wave motions by imposing limits on the allowable frequencies. The effects of the earth's rotation results in motions observed at inertial frequencies. Thus we oberved a complex combination of motions which are only partially understood and has only recently been studied in any detail by spectral-analysis techniques. Strong spectral peaks appear at tidal and inertial frequencies at all depths. Occasionally, spectral peaks appear at frequencies whose origins are unknown.

The Navy, through its in-house and contract research programs, has developed considerable capability in deep-ocean mooring technology, so that at this time it is possible to plan with confidence the establishment of moored-buoy stations for sensing current and temperature field on a continuous basis for periods of two to three months. This capability will be employed in the BOMEX to establish a series of deep-ocean moorings containing current and temperature sensors which will measure currents between the surface and the bottom and temperature between the surface and a depth of 1500 meters. This line of moorings will provide data to examine the spectral density of horizontal motions as a function of latitude, depth, and distance from a boundary. The data from current-meter moorings will be compared to dynamic calculations from oceanographic-station data. The current-meter data will be analyzed to estimate vertically integrated water transport in the area. Such estimates may provide an insight into deep-ocean circulation, particularly deep western boundary currents. Thermistor-array data will be examined for spectral density of vertical motions as a function of latitude, depth, and distance from a boundary.

Environmental-Prediction Evaluations—The Navy Antisubmarine Warfare Environmental Prediction System (ASWEPS) stands to benefit directly or indirectly from almost all of the research projects planned

for the BOMEX. The data gathered and the theories of air-sea interface processes which may be developed will eventually be utilized in oceanographic-prediction techniques. For this reason ASWEPS personnel will observe with interest the operations of BOMEX and apply the results to ASW problems. In addition, they plan to participate actively in the BOMEX by establishing an oceanographic forecasting center on Barbados to issue and evaluate forecasts for the BOMEX area and to conduct aerial oceanographic surveys of the BOMEX area.

Platforms

The Navy ships and aircraft serving as the measurement platforms for the previously mentioned programs are listed in Table 1, together with tentative deployment dates, primary purpose, and sponsoring activities. Total ship time in support of BOMEX is estimated at 160 ship-days. Navy research aircraft time is estimated at 200 flying hours.

In addition to the research aircraft committed to support the oceanographic program, Weather Reconnaissance Squadron Four will conduct weather-reconnaissance flights by diverting one routine recon track (KILO Track) sufficiently to over-fly the BOMEX area. The flights will occur on alternate days, subject to other higher priority missions and required hurricane reconnaissance.

TABLE 1
Navy Platforms

Name	Type	Tentative Periods of Use	Primary Purpose	Sponsor
USNS LYNCH	AGOR	1/11/69 to 2/24/69	Exploratory oceanography, ocean stations, bathymetry cores	NAVOCEANO
USNS GILLISS	AGOR	5/22/69 to 7/17/69	Ocean stations, buoy surveillance, cooperating platform	NAVOCEANO
FLIP	Stable Platform	5/2/69 to 5/30/69	Air-sea interaction	ONR - SIO
FLIP Tug	ATF	5/2/69 to 5/30/69	FLIP service ship	COMSERVPAC
ASWEPS Aircraft	Super Constel-lation	6/7/69 to 6/21/69 7/7/69 to 7/21/69	Sea-surface temperature and waves	NAVOCEANO
NRL Aircraft	Super Constel-lation	June 1969	Photographic wave spectrum	NRL
Weather Recon Aircraft	WC 121N	Alternate days BOMEX	Weather observations	WEARECON Squadron Four

(Continued on Page 27)

Status and Potential of Research Ballooning

H. Demboski
CDR W. R. Wilson
Office of Naval Research

The high altitude balloon began lifting scientific instruments into the stratosphere to take measurements in space long before the advent of the satellite. Recently this vehicle has developed new capabilities which have increased its value to scientists concerned with investigating the upper atmosphere and the near-space environment.

The primary value of the high altitude balloon is that it provides an economical means of lifting instruments above 90 and frequently 99 percent of the earth's atmosphere, which is about 30 miles above the earth's surface. This makes it possible to avoid most of the undesirable, unpredictable and uncontrollable effects of the atmosphere on scientific experiments. Such balloons also permit scientists to conduct research and operational experiments for long periods of time at almost any geographical location.

Since the Skyhook was first developed by the Office of Naval Research 20 years ago, balloon sizes and payload weights have increased by several orders of magnitude. Balloons have swelled in volume from 10,000 cubic feet to over 27,000,000 cubic feet. The weight of scientific payloads has soared from less than 100 pounds to more than eight tons, and altitude increases have been extended from 100,000 feet to 160,000 feet.

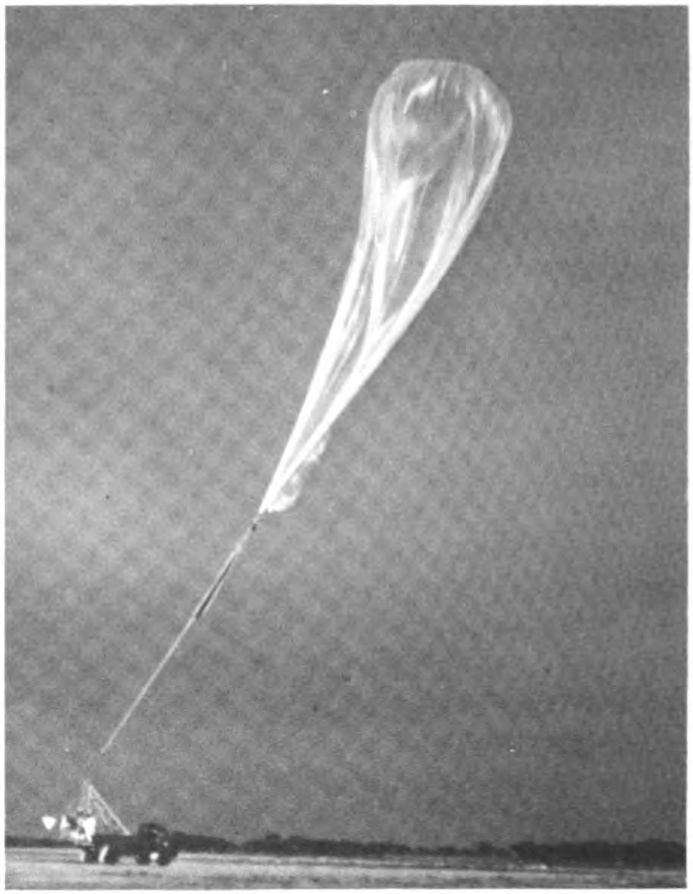
The development of such height capability was not without disappointments. In 1965 flight reliability with polyethylene film, which is the material used in making Skyhook balloons, was about 50 percent. The probability of expensive payload losses or excessive instrumentation damage limited scientific interest and accomplishments. Improved materials and methods have increased the low-tensile strength and decreased the cold brittleness temperature of polyethlene films to such a level that the Skyhook Churchill Program for the past three years has been completed with near 100 percent balloon reliability.

Polyethylene films were developed originally for commercial purposes. Since the amount of polyethylene resin used for balloon fabrication is extremely small compared to the total quantity used by industry, manufacturers did not have much incentive to improve film characteristics specifically for *balloon applications*. Other plastic films, such as Mylar and polypropylene, have been considered for balloons. However, these films are difficult to seal and possess a very low tear resistance. To overcome this limitation, a reinforced Mylar film has been developed

Inflation of 10.6 million cubic foot balloon

for high-altitude flights such as the Stratoscope II balloon-borne 36-inch telescope system. The expensive equipment as well as the scientific objectives involved in these flights justify the much higher cost of such balloons.

Basic research and development in new balloon materials and aerostat design requirements continue in response to the demands of the scientific community. Composite films of polyethylene and polypropylene laminates have been tested and show promise. Sophisticated methods of tapering the extruded thickness of balloon material attest the improved technical capabilities of manufacturers. A recent discovery of strong, lightweight, co-polymer material, which retains a four-fold extensibility at temperatures below −100°F, indicates that extensible film aerostats may allow scientific investigators a means of economically reaching heights in excess of 170,000 feet. Since the Office of Naval Research first sponsored balloon flights many years ago, other agencies have entered the field.

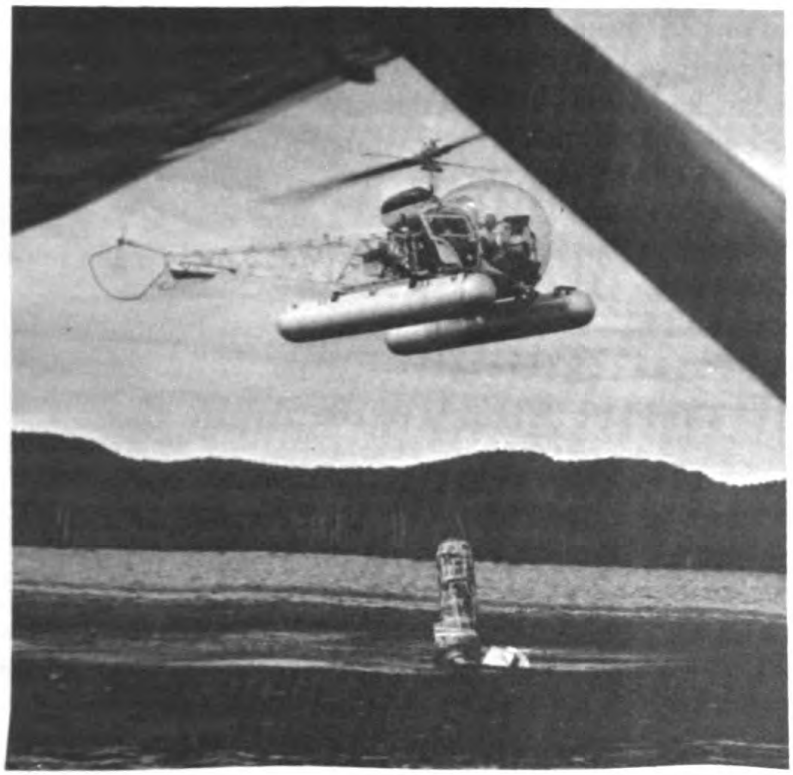


Inflated balloon ready for lift-off

The National Center for Atmospheric Research (NCAR) has established a Balloon Flight Facility at Palestine, Texas. Complete launch, data-collection, control, tracking, and recovery facilities are available to civilian scientists and government agencies. NCAR also operates a more limited balloon flight facility at Page, Arizona. This location is ideal for winter flights because of the extremely light surface winds and favorable float trajectories. These ideal conditions permit static vertical-launches, which are highly desirable for large balloons and scientific payloads because of the delicate handling and release operations involved. Aerostats in excess of 27,000,000 cubic feet volume are scheduled for launch from the Balloon Flight Facility, Palestine during 1969.

The Atomic Energy Commission (AEC) continues a program for sampling upper-air particulate matter utilizing balloon-borne instruments. Under this program, flights are launched from San Angelo, Texas; Fairbanks, Alaska; Panama, Canal Zone; and several other selected sites. Upper-air samples are taken on a quarterly basis from four to six altitudes between 70,000 feet and 135,000 feet. Analysis and monitoring of the sample data are performed by the Environmental Science Services Administration (ESSA).

Scientific payload descending by parachute at termination of balloon flight



Recovery of scientific payload by helicopter

The Office of Naval Research (ONR) provides balloon flight services for scientists sponsored by many agencies. Scientific objectives vary from astronomical observations conducted with remotely controlled balloon-borne telescopes to studies of galactic and solar particles and their atmospheric interactions utilizing nuclear emulsions, spark chambers, and scintillation counters. A large percentage of ONR balloon flights are conducted at high northern altitudes because of deeper penetration of high-energy particles there. Balloon-borne systems are launched from the Fort Churchill Research Range, and the scientific payloads are recovered in the region around Lake Athabaska, Saskatchewan, Canada. Other flights for which geographic locations are not critical are conducted under ONR sponsorship from NCAR, USAF, or contractor facilities.

The United States Air Force (USAF) provides complete balloon launching, tracking, controlling, data collection, and recovery facilities for its in-house high-altitude research program, for its contractors, and for other organizations having programs of interest to USAF. Balloon flights are generally launched from Holloman Air Force Base, New Mexico or Chico Municipal Airport, California. The USAF has also developed a mobile launch capability which permits balloon operation almost anywhere in the world.

Continuous coordination and liaison is maintained between the various scientific ballooning groups through visits, panels, and technical symposia. Research in ballooning technology has overcome long standing limitations in available fabrication materials and flight reliability. New and improved materials await moderate funding to become a reality. In an age where astronomic costs are common, the moderate cost of scientific balloon-borne investigations seems refreshing. The unique capability of Skyhook balloons to remain at high altitudes for long periods of time is well established. The cost of floating scientific payloads at altitudes of 150,000 feet can be established at a few hundred dollars per payload pound.

Climatic History of the Arctic Basin

Sediment cores obtained from Drift Station T-3 have been analyzed with respect to geological, geophysical, biological and climatic history as well as physical properties important to hydroacoustics applications. Utilizing established times of reversals of the earth's magnetic field strata in arctic cores have been dated and sedimentation rates established at 1-2.6mm/1000 years during the last four million years. On the basis of analyses of inorganic sediments and fossile remains in relation to the sedimentation rate it has been determined that there is evidence of continental glaciation in the Arctic Basin four million years ago, this probably representing the beginning of Arctic ice conditions. Composition of sediments, plus display of certain temperature dependent morphological characteristics of fossils, indicate the Arctic has not been warmer that at present for at least 1.5 million years and that there is no evidence of the Artic Ocean having been free of ice in a similar time period.

Complex Molecular Compound Discovered Between the Stars

The discovery of ammonia molecules in an interstellar cloud of dust and gases has been reported by a research group on the Berkeley campus of the University of California. The discovery marks the first time that a relatively complex molecular compound has been definitely identified in the vast regions between the stars. This work has been supported by the National Aeronautics and Space Administration, the Office of Naval Research, and the National Science Foundation.

The finding gains added interest, at least in a speculative sense, because ammonia substances have often been proposed as chemical ancestors of organic compounds and hence as necessary steps toward the origin of life.

The work represents a new opening in radio astronomy research, showing that spectrum analysis in the region of the shortest radio wavelengths will yield valuable evidence about the chemistry and other properties of matter far beyond the earth. In addition to detecting the ammonia molecules, the Berkeley group was able to calculate their temperature and estimate their density.

To make the discovery, the researchers used a new 20-foot radio telescope and sensitive receiving equipment located at the University of California's Radio Astronomy Observatory near Hat Creek, California.

The report of the work was published Dec. 16 in *Physical Review Letters,* issued by the American Institute of Physics.

The researchers said the molecules of ammonia gas are quite abundant in a turbulent but cool cloud of dust and gases located in the direction of Sagittarius. The region is also in the direction of the center of the Milky Way Galaxy, an area that is obscured by dust from optical observation but has been the subject of much interest in radio astronomy.

The apparent size of the dust cloud was calculated in astronomical terms at one-tenth of a degree. This might suggest a diameter for the cloud of a few light years, the researchers said. The distance of the cloud from the earth has not been calculated; for comparison, however, the galactic center is located some 30,000 light years away.

By comparing the relative intensity of two distinctive ammonia lines in the microwave radio spectrum, the researchers were able to calculate the temperature of the ammonia molecules at approximately 25 degrees K (that is, above Absolute Zero), or 420 degrees below zero Farenheit. This is indicated as an actual or kinetic temperature, resulting from the random motion and collision of molecules. The temperature measurement itself represents a new degree of accuracy in this

phase of microwave astronomy, and it may open the way for additional new research.

The estimated density of the interstellar ammonia gas is about one molecule per liter, and it is probable that at least one per cent of the available nitrogen in the region is contained in the molecular form.

The measurements also suggest a relatively high overall density of the interstellar cloud, with the bulk of the matter probably consisting of molecular hydrogen (H_2). This total density might be in the order of a million molecules per liter.

An ammonia molecule consists of a nitrogen atom joined to three hydrogen atoms, with the chemical symbol NH_3. Ammonia gas dissolved in water yields the common household cleaning agent known as ammonia water.

Formation of ammonia molecules by random atomic collisions in space would be unlikely, the report noted. Instead, the Berkeley researchers suggested that the molecules might be formed on the particles of interstellar dust by surface catalysis, a process familiar in laboratory work and in the chemical industry. Once formed, the molecules could be thrown off the dust particles by the process of sublimation (ice-to-gas evaporation), other processes triggered by light energy, or possibly bombardment by nuclear particles.

Conditions in much of interstellar space are regarded as too severe to allow for the existence of molecules. Ultraviolet radiation in starlight would destroy ammonia molecules in a relatively short time. However, molecules inside a cloud of dust and gases would be somewhat protected from such radiation, and might survive for a much longer time.

Only four decades ago, it was common belief that the space between stars was completely empty. Research evidence has gradually filled this emptiness, first with interstellar dust, then with elemental gases and simple molecules, and now with more complex molecules. At the same time theories have grown to explain how matter between the stars may evolve to form new stars, planets, and perhaps life itself.

The fact that something more than empty space fills the void between stars was first revealed by Astronomer Robert J. Trumpler at the University of California's Lick Observatory in 1930. His experiments on light scattering showed that some kind of dust obscures the light from the stars. The exact nature of this dust is still unknown, but some believe it may prove to be tiny bits of ice with other substances adhering to the surfaces.

After radio astronomy research opened in the 1940's, vast quantities of hydrogen were discovered in interstellar space through detection of a telltale hydrogen line in the radio spectrum.

In more recent years, radio astronomers at Massachusetts Institute of Technology, and later at Berkeley and other centers, have reported discovery of other lines indicating the presence of hydroxyl molecules

in several interstellar regions. Hydroxyl is a chemical radical consisting of single atoms of oxygen and hydrogen (with the chemical symbol OH). Its discovery in space led to intense radio explorations and the finding of several unique phenomena, including OH sources not much larger than gaint stars and energy output apparently boosted by maser processes.

Both interstellar dust and OH molecules have been detected in the cloud where ammonia molecules have now been discovered. There may be other gaseous compounds as well, and the search for them through microwave and other techniques will undoubtedly now be intensified. Likely candidates might include water, methane, and other combinations of hydrogen, oxygen, carbon, or nitrogen atoms.

According to a number of theories and a fair amount of indirect evidence, new stars may be born in the gravitational condensation of interstellar clouds of dust and gas. Planets may also be formed from the same condensing matter, and some of the material may be gathered in planetary atmospheres. It has been found, in fact, that ammonia is present in the atmosphere of Jupiter and probably of Saturn, and the new discovery suggests that this may have an origin in the primordial dust cloud that preceded the formation of the solar system.

There is speculation that ammonia also existed in the earth's atmosphere in an early period. If so, it may have played a key role in forming the first organic compounds through chemical changes triggered by electrical discharges or other energy processes. Some of the steps in such a proposed chain of chemical transformations leading toward the beginning of life have been duplicated in laboratory experiments.

The new radio telescope at Hat Creek, in operation about six months, has an extremely smooth aluminum reflector surface. This has enabled the researchers to make accurate observations in the microwave region of the radio specturm (in this case, from about two centimeters wavelength down to two or three millimeters), a region of the spectrum where signals from space are usually faint. As it has turned out, the interstellar ammonia sources appear to be among the brightest spots (in radio terms) in this spectral region. The microwave energy emission from the ammonia molecules in space was described as steady and normal for the substance at the observed temperature.

The detection of the distinctive ammonia feature in microwave astronomy can provide an important reference point for future radio exploration, the Berkeley group pointed out, just as the hydrogen and OH lines have served as useful beacons in other phases of radio astronomy research.

The new discovery was possible only because the microwave spectrum of ammonia had been carefully measured and well understood in earlier laboratory experiments an accomplishment that has proved useful in many lines of physics and chemistry study.

The Whole World Metric, But When?

Dr. Harley J. Walker
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London

The metric band-wagon is becoming increasingly popular, although there is certainly no need to fear overcrowding. Indeed, at present, almost 90 percent of the world's population is using the metric system. Of those countries left, no fewer than 11 are now seriously considering going metric, and recently others-most notably the United Kingdom-began the expensive and arduous process involved in the conversion.

Several recent articles-for example, "Industry Takes the Metric Road," *New Technology*, May 1968; "Australia Goes Metric," *Nature*, June 1968; "Imperial Demise," *Nature*, August 1968, emphasize the increasing rate of adoption.

In 1950 the British Committee on Weights and Measures strongly recommended that the metric system be substituted for the imperial. Subsequently, opinion in Great Britain favoring the change grew, although it was not until 1966 that the Ministry of Technology appointed a Standing Joint Committee on Metrication. This Committee, given the charge to "encourage, assist and review the progressive adoption within British industry of the metric system of weights and measures," published its report "Change to the Metric System in the United Kingdom," in July, 1968.

Broad timetables for adoption by the engineering industries are being completed. The change-over which is to begin in 1970, will be 80 percent complete by 1975. Converting industrial standards into metric terms, especially so they harmonize internationally, is no mean task. In any event, at present, complete uniformity is impossible because slight differences in metric practice still exist around the world. However, attempts are being made to iron out these differences by groups such as the International Standards Organization.

Now that the change from imperial to metric for industry is committed, other sectors of the economy must follow although no definite time schedule has yet been published. It has been suggested that conversion in the retail sector should be initiated by 1971 (the year decimal coins will be in), and completed before 1975. In schools, attempts are being made to have the emphasis metric by 1969.

At the present time, all of Europe, except the UK and the Irish Republic, is metric. Therefore, Britain's conversion is not only economically necessary but also politically expedient. It is calculated that it will be accepted "by European countries as evidence of the United Kingdom's determination to become a more integral part of Europe." Britain's decision is having a much wider influence. For example, it

was a major factor, although by no means the only one, influencing the recent recommendation that Australia also go metric.

The present trend is such that the United States and Canada are likely soon to be the only major countries left on a non-metric system. However, even in these two countries metric study bills are before both governments. Because conversion would be more difficult in the United States (due to its heavy industrialization) and because the United States is not being "pressured" into a switch (90 percent of its products are consumed internally), conversion to the metric system does not appear imminent, even though it is certainly inevitable.

One further thought. It is just a matter of time until the Englishman will walk into his favorite pub and order a half liter of beer instead of his usual pint and pay for it with 7.5 pence instead of the usual one and six. One wonders what other changes might be forthcoming in these revolutionary days. Will left-hand driving be the next to go?

Navy's Role in BOMEX—Continued from Page 17

The Navy participation in BOMEX represents a significant contribution to a cooperative federal program of ocean exploration. It brings together not only the Navy in-house capabilities for scientific research in the field of air-sea interaction, but also those of Navy contractors from universities, insitutions, and private industry. This coordinated teamwork is expected to lead to a far better understanding of the phenomena in question than if the several problems were approached independently and individually. At the same time, BOMEX affords the investigators the opportunity to learn first hand from each other the techniques, problems, and successes which may affect their own work.

NOTE: Abstracted from publication *BOMEX*, MC Report 1, January 1969, Ocean Science Program, Maury Center for Ocean Science, Department of the Navy.

Legion of Merit Presented to CDR Brodine

CDR Charles E. Brodine, MC, USN, Director, Clinical Investigation Department, was presented the Legion of Merit in the name of the President of the United States on 3 January by VADM Robert B. Brown, MC, USN, Surgeon General. The presentation ceremony was held at BuMed and attended by Dr. Brodine's associates from Navy Medical Research Institute (NMRI) and other organizational units of the Navy Medical Department.

The Legion of Merit was presented "for exceptionally meritorious service from January 1966 to December 1968 as Project Director of the Bureau of Medicine and Surgery's Frozen Blood Research Project." CDR Brodine was responsible for and directly supervised the research and development of frozen blood for use by the Armed Forces under combat conditions during this period.

Research Note

Deep Sea Drilling Project

The floor of the Atlantic Ocean appears to be moving slowly away from the central or median line of the ocean. Scientists on board the Glomar Challenger, participating in Leg II of the Deep Sea Drilling Project, have found important evidence strongly substantiating this hypothesis called "sea-floor spreading." Scripps Institution of Oceanography of the University of California at San Diego is managing the Deep Sea Drilling Project, which is part of the National Science Foundation's National Research Program of Ocean Sediment Coring.

The direct evidence that bears on this theory comes from samples recovered by drilling and coring deep beneath the floor of the ocean along a track extending from near Bermuda, across the Mid-Atlantic Ridge, to near the Cape Verde Islands, off the west coast of Africa. Drilling took place at five sites, and 715 feet of core was recovered. Sites were chosen based on information contained in pictorial records, called sub-bottom profiles, which are obtained by reflecting sound. The sub-bottom profiles show layers of sediment, and beneath these the so-called "basement" on which the sediments accumulated.

Until the advent of deep sea drilling, we did not have samples from deep beneath the floor of the ocean. As a result of these samples we now know exactly what indirect measurements such as sub-bottom profiles really mean; and the samples help in the interpretation of a large amount of data already available from years of study. In the past we only knew that there were reflecting layers and varying thicknesses of sediment. Now, where drilling has recovered samples, we know what these layers of sediment are and can determine their age. The age of these sediments can be determined by studying the minute skeletons of animals and plants that grew in the surface waters and sank becoming entombed as part of the sediment.

Reaching the basement with the drill bit was an essential part of the task since the expedition was largely designed to test the theory of sea-floor spreading. At three separate sites leading up the west flank of the mighty Mid-Atlantic Ridge, the basement was penetrated for a short distance.

When the basement was first penetrated, only a handful of fragments of altered, vesicular basalt was recovered, but this achievement set many records. This drilling was accomplished at the end of the longest drill string ever suspended from a floating platform, 19,075 feet; and the sample was reached at the bottom of the deepest penetration ever achieved into the floor of the deep oceans, 2,740 feet. While making this first attempt to recover a basement sample, drilling was done with the greatest caution. As each foot of penetration set a new record, it was possible to tell that the goal of the basement was being approached because the character of the sediment changed to brick red due to accumulations of iron. After drilling for almost an hour without significant penetration the final core was recovered from the site. At the next encounter with the basement the entire contact between sediment and basement was recovered, along with about ten feet of continuous core into the basement, which was composed of layers of vesicular basalt lava flows. Above the basalt the sediment had been hardened into a marble, and there were stringers of glass in the sediment near the contact. At the third drilling site, about one foot of hard basalt was recovered from the basement, and of particular significance was the finding of a thin layer of baked and hardened carbonate sediment caught between two successive layers of basalt lava flows.

The remarkable technical achievement of drilling in the deep oceans has permitted asking the critical question, what is the age of the oldest sediment, just above the igneous rock basement? Having reached the basement it is possible to argue that, except for a

small amount of sedimentary history lost as thin layers of sediment caught between lava flows, the very first sediments to have been deposited on the floor of the ocean at each of the three sites up the flank of the Mid-Atlantic Ridge had been recovered.

The ages of these first-formed sediments are systematically younger upon approaching the crest of the Ridge in the center of the Atlantic. Thus the ages of the underlying basement can be taken to be successively younger toward the center of the ocean. About 100 miles from the crest of the Ridge the maximum age is about 18 million years or Middle Miocene. At about 500 miles, on the lower flank the oldest sediment is 85 million years old or Upper Cretaceous. At 850 miles, off the Ridge itself and on the east side of what is now the Bermuda Rise, the oldest sediment dated is also 85 million years, Upper Cretaceous; however, beneath this lowest dated horizon are about 200 feet of additional sediment that cannot be adequately dated by fossils but which must be older. Even farther west from the Ridge Leg I recovered Jurassic sediments about 140 million years old without reaching the base of the sedimentary section. It can be seen in the sub-bottom profiles that successively older and deeper horizons are present at increasing distance from the crest of the Ridge; we now know the actual age of these sediments.

The total sediment layer becomes generally thinner toward the central part of the ocean. Profile records show that the layer ranges from a complete sediment mantle that covers basement surface irregularities far from the center of the ocean to a thin and discontinuous layer trapped in pockets and ponds high on the Ridge. Sediment is almost nonexistent at the very crest itself.

These results are all consistent with the theory of a continuous formation of new oceanic crust along the very center of the Atlantic Ocean. This newly formed crust spreads slowly aside, continuously accumulating sediment throughout millions of years as it moves.

Calculations, based on the results of deep sea drilling, indicate that the rate of seafloor spreading must have been somewhat variable through time. Over the past 18 million years the average rate has been about one cm per year. During Cretaceous time, about 85 million years ago, the rate of formation of new oceanic crust must have been at least several times more rapid.

The exact way new oceanic crust is formed at the center of the Ridge-system is not well understood; however, the important discovery of an interbedded thin layer of sediment with obvious flows of basalt presents some clues. The formation of the new oceanic crust must take place by molten rock being emplaced in rifts and fissures along the central trend of the ocean. Some of this molten material finds its way to the surface and flows out as vesicular basaltic lava. As the crust slowly spreads, the frequency of flows reaching a particular portion of the ocean floor from the centrally located source drops off. Thin layers of sediment have time to accumulate and be subsequently covered by more of these surface lava flows. One such thin layer of baked sediment was recovered by the drilling. The top of the basement, or basement associated rocks, then, is the last lava flow to reach any particular area, during its slow migration away from the central source.

Some of the characteristics of the sediment are clearly related to the formation or presence of the basement igneous rocks. Abundant iron oxide in sediments just above the basement in one site, abundant dolomite, a magnesium bearing carbonate mineral, in another site, and the baking and consolidation of sediments in and just above the lava flows are examples.

Evidence was also found to indicate that the central ridge system was probably not as high in the past as it is today. During the Eocene, about 65 million years ago, important changes in the circulation and chemistry of the Atlantic Ocean created conditions suitable for the formation of silica-rich sediments and layers of chert, commonly called flint, on an ocean-wide basis. Data also permitted an *in situ* measure of the average velocity of sound which forms a basis for the interpretation of sonic profiles in terms of real depths.

On the Naval Research Reserve

Outstanding Drill Meetings

Two Research Reserve Companies reported on their excellent drill programs—NRRC 6-6, Chapel Hill, North Carolina and NRRC 5-8, Washington, D.C. Both exemplify the meaningful and informative type of technical program presented in the ninety-one companies of the Research Reserve.

NRRC 6-6

Naval Reserve Research Company 6-6 is located in the Triangle area of North Carolina where there are many research activities: three universities, two medical centers, a research park, and local industries. These centers provide not only many qualified speakers but also a membership of reserve officers who are research oriented in either the natural or social sciences.

Aside from learning about the activities of such industries as Chemstrand and IBM and such research organizations as the Research Triangle Institute and the Environmental Health Center, NRRC 6-6 has had or will have the opportunity to visit several unique research facilities. Among these facilities are the Morehead Planetarium at the University of North Carolina where the astronauts are taught space navigation; the most versatile hyperbaric and hypobaric chambers in the nation are at Duke University in which five divers recently descended to 1000 feet in an advanced study for the Navy's deep sea program; a high energy physics research facility at Duke and a nuclear engineering facility at North Carolina State University; one of the largest and sophisticated phytotron complexes in the country located at Duke and North Carolina State University; marine biological facilities of both the University of North Carolina and Duke including Duke's marine research ship and world-famous Institute of Parapsychology.

After concluding a course on digital computers and programming, NRRC 6-6 had two programs on the applications of a computer in medicine. Duke provided the speaker for a program on the Myocardial Infarct Research Unit, one of nine such units in the country; and Dr. Ralph Stacy of the University of North Carolina demonstrated a very promising patient-monitoring system. A program on the history and the development of integrated circuits outlined the unbelievable ten year growth of a field which has a tremendous impact on society. An electrical engineer from Duke discussed the field of lasers and their applications. LCDR K. L. Penegar, USNR, who just returned from a year's study in India, discussed his work.

Planned activities include such topics as international monetary systems, PERT, and CPM, highway safety research by a member of the Institute of Government at the University of North Carolina, and research on social systems. CAPT J. R. Lyman, USNR, will present a discussion on Ocean Resources and Ownership of the Sea. An up-to-date look at Vietnam is planned by a recent Swift boat commander who just returned from Vietnam.

LCDR William E. Hammone, USNR, is the Commanding Officer of NRRC 6-6. The company meets 24 times a year during the universities' fall and spring terms.

NRRC 5-8

Each company of the Naval Reserve Research Program has its special advantages due to its location and its members. These advantages are apparent when reviewing the quarterly program schedules of the companies. There is a broad spectrum of subject matter presented and a uniformly high professional level of speakers.

The Research Reserve Companies of the Washington, D.C. area, for example, are particularly fortunate in their geographic location which permits them to draw upon technical and professional men from government as well as laboratories and universities.

During the second quarter of the Fiscal Year 1969 program, NRRC 5-8 examined various aspects of the Navy's research and development efforts and related budget planning. The speakers were:

- Mr. George A. Spangenberg, Head, Evaluation Division, Naval Air Systems Command
- CAPT Sterling H. Ivison, USN, Assistant Director of Budget and Reports Office of the Comptroller
- Dr. Merrill I. Skolnik, Head, Radar Branch, Naval Research Laboratory
- RADM C. E. Bell, Jr., USN, Director, General Planning and Programming, Office of the Chief of Naval Operations
- RADM Paul A. Holmberg, USN, Vice Commander, Naval Air Systems Command
- CDR M. Petersen, USNR, Chairman, Department of Armed Forces History, Smithsonian Institute.

NRRC 6-18 Tours Air Control Center

NRRC 6-18 visited the Metropolitan Airport Control Center, Nashville, Tennessee and observed from behind the scenes landings, take-offs, and holding patterns of a major metropolitan airport.

The Nashville Air Traffic Control Center has the enviable record of having no fatal air crashes since World War II. This safety record

may well be attributed to the skill of the air control staff. Several research reservists who were former naval aviators were particularly interested in the new radar installation at the Center. There is a special importance in the Nashville Air Traffic Control Center because it has been designated as a training facility for new air controllers.

Naval District Trophy to NRRC 1-1

RADM Roy S. Benson, USN, (Ret.), former Commandant of the First Naval District, Boston, Massachusetts, formally awarded the District's Specialist Unit Trophy to Naval Reserve Research Company 1-1 of Boston at a uniform drill 2 December 1968 at the local Naval Reserve Training Center.

CDR Charles F. Davis, Jr., USNR, Commanding Officer and previous Executive Officer of the unit, received the Admiral's congratulations and the trophy. CDR Paul St. George, USNR, was commended by the Admiral for his successful leadership as the Commanding Officer of NRRC 1-1 during the period of the award. CDR Don M. Aulick, USN (Ret.), Program Officer for the Research Reserve who recently retired, was given a letter of commendation by the Admiral. Assisting in the award ceremonies was CAPT Charles F. Simonet, USNR, Deputy Chief of Staff for Naval Reserve and Training, First Naval District.

(From left to right): CDR Don M. Aulick, USN (Ret.), CDR Paul W. St. George, USNR-R, CDR Charles F. Davis, Jr., USNR, and RADM Roy S. Benson, USN (Ret.)

Selected Contract Research Reports

The contract research reports listed below have been extracted from U.S. Government Research & Development Report 68, No. 22 of 25 November 1968 and No. 23 of 10 December 1968. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in USGRDR 68, Nos. 22 and 23.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 21151.

AERONAUTICS

A Study of an Optical Technique for the Measurement of Airspeed; General Instrument Corp.; Rossoff and Nathan; AD-675 987

ASTRONOMY AND ASTROPHYSICS

Reduced Values of Solar Radiation with Occurrence of Dense Smoke Over the Canadian Tundra; Wisconsin U.; Peterson and Drury; AD-676 099

Physics of the Solar Corona; Colorado U.; Billings; AD-674 896

Further Observations of Pulsating Radio Sources at 13 cm; CalTech; Ekers and Moffet; AD-675 203

Solar Radiation and Atmospheric Absorption in the mm Wave Region; Calif. U.; Silver and Welch; AD-675 267

ATMOSPHERIC SCIENCES

Coordinated Particle, Optical and Electron Content Measurements in Auroras; Lockheed Missiles and Space Co.; Evans and Johnson; AD-674 966

Magnitude of Terms in the Equation for Large-Scale Atmospheric Motions; Minn. U.; Mantis; AD-675 395

Letters on the Transport of Material Across the Tropopause; Minn. U.; Kroening *et al;* AD-675 520

Correlation of Pc 1 Micropulsations at Spaced Stations; Newcastle U.; Manchester; AD-675 764

Simultaneous Observations of Electrons (E Greater Than 45 KeV) at 2,000 Kilometers Altitude and at 100,000 Kilometers in the Magnetotail; Iowa U.; Rao *et al;* AD-675 782

Some Observations of Energetic Electrons in the Outer Radiation Zone During Magnetic Bays; Iowa U.; Rao; AD-675 958

On the Question of Low-Level Cloud Response to the Temperature Field of the Sea Surface; Texas A & M U.; Arnold; AD-676 231

BEHAVIORAL AND SOCIAL SCIENCES

When Planning for Others; Rochester U.; Bass; AD-675 785

A Preliminary Report on Manifest Preferences in Six Cultures for Participative Management; Rochester U.; Bass; AD-675 786

On the Assessment of the Training Value of Small Group Exercises for Managers; Rochester U.; Bass *et al;* AD-675 787

Determinants of Bargaining Outcomes; Smithsonian Institution; Kent; AD-675 967

The Egyptian Revolution: Nasserism and Islam; Mass. U.; Lewy; AD-676 219

A Systems Analysis Theory for Displays in Manual Control; Systems Technology Inc.; McRuer *et al;* AD-675 983

The Human Subject in Psychological Research; North Carolina U.; Schultz; AD-675 828

Some Test Theory for Tailored Testing; Educational Testing Service; Lord; AD-675 829

Coalitions and Strategy in Small Groups; St. U. of N.Y.; Vinacke; AD-675 831

A Test of Scotopic Suppression of the Photopic Process; Kansas St. U.; Brown; AD-675 941

Operant Reinforcement of a Skeletally Mediated Autonomic Response: Uncoupling of the Two Responses; Calif. U.; Gavalas; AD-676 095

Reported Amount of Contact and Sterotyping; Ill. U.; Triandis *et al;* AD-676 232

Interpersonal Influence and Employee Selection in Two Cultures; Ill. U.; Triandis and Vassiliou; AD-676 233

City and Village in Iran: Settlement and Economy in the Kirman Basin; National Academy of Sciences—National Research Council; English; AD-675 718

Cross-Cultural Training as a Means for Improving Situational Favorableness; Ill. U.; Chemers; AD-676 234

Authority Relations and Governmental Performance, a Theoretical Framework; Princeton U.; Eckstein; AD-675 327

PARM-an Economic Programming Model; National Planning Association; Wood; AD-675 343

Experimental Retrieval Systems Studies. Transition to On-Line Information and Reference Retrieval; Lehigh U.; Smith, Jr. *et al;* AD-674 954

An Appreciation of Industrial Dynamics; Carnegie-Mellon U.; Ansoff and Slevin; AD-675 347

Studies in the Phonology of Asian Languages. Korean Affricates; U. of S. Calif.; Han and Ross; AD-674 932

Interpersonal Approach-Avoidance and Fear of Failure; Bucknell U.; Portnoy and Teevan; AD-674 876

Negotiations and Decisions in a Politics Game; St. U. of N. Y.; Vinacke; AD-675 056

Behavioral Biophysics; Inst. for Research; Frey; AD-675 118

Two Fear of Failure Motives and Their Comparison in Relation to Persistence, Scores on Rotter's Internal-External Scale and Attitudes Toward a Real Achievement Situation; Bucknell U.; Teevan *et al;* AD-675 497

Learning; Naval Unit; Glaser; AD-675 502

Values, Attitudes, and Multi-National Decision-Making Introduction; Western Behavioral Sciences Inst.; Raser; AD-675 516

Perception and Interaction in Simulate International Systems; Western Behavioral Sciences Inst.; Ruge; AD 675 517

BIOLIGICAL AND MEDICAL SCIENCES

Biosynthesis of 2-Aminoethylphosphonic Acid in Tetrahymena; City of Hope Medical Center; Horiguchi *et al;* AD-675 027

Identification of the Major Glycolipid From Mycoplasma sp., Strain J as 3,4,6-Triacyl-Beta-D-Glucopyranose; S. Dak. U.; Smith and Mayberry; AD-675 302

Bibliography of Germfree Research. 1967 Supplement; Notre Dame U.; Teah; AD-674 929

Nematode Parasites of Oceanica. Arthrostoma Vampira sp. n., With a Reconsideration of Those Hookworms Having Articulated Buccal Capsules; Warren Spring Lab. (England); Schmidt and Kuntz; AD-674 930

A Genetic Defect in "Aquired" Agammaglobulinemia; Calif. U.; Kamin *et al;* AD-675 029

A Restraint Device for Cats in an Ultrahigh Frequency Electromagnetic Energy Field; Inst. for Research; Frey and Thornton; AD-675 344

Receptor Sites of Human Monocytes for IgG; Calif. U.; Huber and Fudenberg; AD-674 967

Experimental Controls and Biological Experiments with Atmospheric Ions; Inst. for Research; Frey; AD-675 024

Observations on Contracting Monkey Hearts Maintained in Vitro at Hypothermic Temperatures; Americal Foundation for Biological Research; Malinin and Perry; AD-675 119

A Coxial Pathway for Recording from the Cat Brain Stem During Illumination with UHF Energy; Inst. for Research; Frey *et al;* AD-674 947

Endogenous Biorhythmicity Reviewed with New Evidence; Northwestern U.; Brown, Jr.; AD-675 303

Immunochemical Studies on Blood Groups. Structures and Activities of Oligosaccharides Produced by Alkaline Degradation of Blood-Group Lewis Substance. Proposed Structure of the Carbohydrate Chains of Human Blood-Group A,B,H,LEa and LEb Substances; Columbia U.; Lloyd *et al;* AD-676 084

Ectoparasite and Host Collections From Nepal; American U.; Lewis; AD-675 940

Instrumentation for Animal Tracking and Data Acquisition; American Electronic Labs, Inc.; Starks and Ostroff; AD-675 974

Nutritional Studies of the Edible Seaweed Porphyra Tenera. The Influence of Different B12 Analogues, Plant Hormones, Purines and Pyrimidines on the Growth of Conchocelis; Haskins Labs.; Iwasaki; AD-676 087

Nutritional Studies of the Edible Seaweed Porphyra Tenera. Nutrition of Conchocelis; Haskins Labs.; Iwasaki; AD-676 098

Effects of Salinity and Nutrients on Mono- and Diaxenic Cultures of Two Strains of Artemia Salina; Haskins Labs.; D'Agostino and Provasoli; AD-676 102

Myocardial and Splenic Levels of Catecholamines In Burn Shock; Loyola U.; Cova and Glaviano; AD-675 696

The Independence of the Lysolecithinase Activity of Extracts of Clostridium Sordellii From Their Lethal Oedema-Producing and Haemorrahagic, Action; Oxford U. (England); Mellanby and White; AD-675 658

The Effect of Cerebroside and Other Lipids on the Fixation of Tetanus Toxin by Gangliosides; Oxford U.; van Heynigen and Mellanby; AD-675 760

The Kidney Response to High Oxygen Pressure; Pa. St. U.; Selman and Houlihan; AD-676 089

CHEMISTRY

Equilibration of a Uniform Two-Temperature Mixture of Maxwell Molecules; Northwestern U.; Jhunjhunwala and Mintzer; AD-675 755

An Experimental Study of the Conformation Polyisobutylene in a Hydrodynamic Shear Field; M.I.T.; Cottrell; AD-675 827

The Equilibrium Melting of Homopolymers; Rensselaer Polytechnic Inst.; Prime; AD-675 960

Adsorption at the Rutile-Solution Interface. Thermodynamic and Experimental Study; M.I.T.; Berube and De Bruyn; AD-675 973

The Distribution of Angular Correlation in Two-Electron Atoms. The 2 (1)S State of Helium; Ill. U.; Tatum; AD-676 149

The Reaction Kinetics of Gaseous Hydrogen Atoms with Graphite; Purdue U.; Wood and Wise; AD-676 237

Infrared Spectra of Matrix Isolated Alkali Metal Metaborates; Pa. U.; Seshadri *et al;* AD-675 045

Spectroscopic Investigation of the Structures of the Crystalline Phases of Acetylene; Mich. St. U.; Smith and Leroi; AD-675 272

Time-Resolved Nanosecond Emission Spectroscopy: Spectral Shifts Due to Solvent-Solute Relaxation; Minn. U.; Ware *et al;* AD-675 285

The Pressure-Induced Infrared Spectrum of Methane; Mich. St. U.; Weiss *et al;* AD-675 325

Raman Intensities of Lattice Modes in Molecular Crystals; Mich. St. U.; Cahill; AD-675 326

Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules; Harvard U.; Ozier *et al;* AD-675 390

Photochromism of Salicylidene Aniline; Sperry Rand Corp.; Andes and Manikowski; AD-675 016

EARTH SCIENCES AND OCEANOGRAPHY

Wave-Ice Interaction; Stevens Tech.; Evans and Davies; AD-674 895

Experiemnts in Oceanic Forecasting for the Advective Region by Numerical Modeling. Gulf of Mexico; Lockheed-Calif. Co.; Baer *et al;* AD-674 962

A New Set of Oceanic Diffusion Diagrams; Johns Hopkins U.; Okubo; AD-675 269

Radiocarbon Dating of Lacustrine Strands in Arctic Alaska; Arctic Inst. of North America; Carson; AD-675 028

Hydrographic Station Data, Gulf of Mexico, February-March Nansen Casts, 1965-1968; Texas A & M; Leipper; AD-674 917

Hydrographic Station Data, Gulf of Mexico, February-April STD, 1967-1968; Texas A & M; Leipper; AD-674 918

Isotope Analysis of Seawater by Mass Spectrometry; Scripps; Chow; AD-674 956

Organic Carbon and the Oxygen Minimum in the South Atlantic Ocean; Woods Hole; Menzel and Ryther; AD-675 350

Radiance of Sea and Sky in the Infrared Window 800-1200 cm; Woods Hole; Saunders; AD-675 351

Passive Microwave Measurements of Snow, Ice and Soil; Aerojet-General Corp.; Edgerton; AD-674 927

An Analysis of Subsurface Currents and Temperatures at a Site on the Continental Shelf of the Northeast United States; General Dynamics Corp.; Griscom; AD-675 826

Abstracts of Reprints Supported by ONR July 1967-May 1968; Scripps; AD-676 217

The Behavior of Solitary Waves on a Stepped Slope; Stanford U.; Street *et al;* AD-676 220

Geography and the Properties of Surfaces. The Descriptive Geometry (or Representative) of a Collection of Points Fixed by N Coordinate Numbers or of N-Dimensions; Harvard U.; Reis; AD-675 962

Geography and the Properties of Surfaces. Plane Globe Projection. A Linnean System of Map Projection; Harvard; Warntz and Maurer; AD-675 812

Land Utilization in the Karst Region of Zgornja Pivka, Slovenia; NAS-NRC; Alexander; AD-676 210

Non-Destructive Laboratory Measurement of Marine Sediment Density in a Core Barrel Using Gamma Radiation; Ill. U.; Preiss; AD-675 767

Submarine Canyons and Sagami Trough, East-Central Honshu, Japan; NAS-NRC; Chamberlain *et al;* AD-675 772

ELECTRONICS AND ELECTRICAL ENGINEERING

Resource Allocation in Multiprocess Computer Systems; M.I.T.; Denning; AD-675 554

A Report of Experience with On-Line Programming; Md. U.; Hilsenrath; AD-675 808

A Statistical Model for Console Behavior in Multi-user Computers; M.I.T.; Denning; AD-675 909

Problem Solving and Learning by Man-Machine Teams-Progress and Planned Investigations; System Development Corp.; Hormann; AD-676 123

Analysis of Signal Processing in a Two-Element Antenna Array Using Hybrid Junctions; Syracuse U.; Cummins and Tuck; AD-675 809

Linear Antennas in Plasma Media; Purdue U.; Lytle and Schultz; AD-674 887

MATERIALS

An Ionic Thermocurrent Spectrometer; Utah U.; Shelley and Miller; AD-674 878

Wedge-Like Waves in a Composite Medium; Northwestern U.; Achenbach; AD-675 026

Investigation of High Strength Steels Under History Program Fatigue; Columbia U.; Branger and Ronay; AD-674 880

Stress-Wave Characteristics of Fracture Instability in Constructional Alloys; Aerojet-General Corp.; Hartbower *et al;* AD-674 881

Calculation of Interdiffusion Coefficients Considering Variations in Atomic Volume; Fla. U.; Guy *et al;* AD-675 317

Diffusion of Zinc-65 in Copper-Rich Solid Solutions of the Copper-Nickel-Zinc System; Fla. U.; Oikawa *et al;* AD-675 318

An Experimental Method for Determining Poisson's Ratio of Elastomers; Columbia U.; Rightmire; AD-675 048

MATHEMATICAL SCIENCES

On the Observability of Linear Time-Invariant Systems with Unknown Inputs; Calif. U.; Basile and Marro; AD-675 054

On Steinitz's Theorem Concerning Convex 3-Polytopes and on Some Properties of Planar Graphs; Wash. U.; Barnette and Grunbaum; AD-675 288

Static Decision Models for Queueing Systems with Non-Linear Waiting Costs; Stanford; Stidham, Jr.; AD-674 886

A Problem in Optimal Search and Stop; Stanford; Ross; AD-675 204

Utility Theory; Research Analysis Corp.; Fishburn; AD-675 346

On the Number of Solutions to the Complementary Quadratic Programming Problem; Calif. U.; Murty; AD-675 385

A Note on Linear Programming and Integer Feasibility; Carnegie Mellon U.; Glover; AD-675 499

Consistent Estimates of the Parameters of a Linear System; Carnegie-Mellon U.; Anderson, Jr. *et al;* AD-675 731

On Newton-Like Methods; Wisconsin U.; Daniel; AD-675 790

On the Approximate Minimization of Functionals; Wisconsin U.; Daniel; AD-675 791

On the Convergence of a Numerical Method for Optimal Control Problems; Wisconsin U.; Daniel; AD-675 792

An Analysis of "Boundary Value Techniques" for Parabolic Problems; Wisconsin U.; Carasso and Parter; AD-675 796

On the Discretization Error of the Dirichlet Problem in a Plane Region with Corners; Md. U.; Laasonen; AD-675 807

Characterization of the Kernels of Convex Games; Princeton U.; Maschler *et al;* AD-676 213

MECHANICAL, INDUSTRIAL, CIVIL, AND MARINE ENGINEERING

Mean Free Path Effect in Spiral-Grooved Thrust Bearings; Mechanical Technology, Inc.; Hsing and Malanoski; AD-675 947

Higher Order Approximations in the Asymptotic Solution of the Reynolds Equation for Slider Bearings at High Bearing Numbers; Mechanical Technology, Inc.; DiPrima; AD-675 948

Shipboard Information System. Project Summary and Conclusions; NAS-NRC; AD-675 775

Shipboard Information System: Instructions and Coding Manual; NAS-NRC; AD-675 776

Theory and Practice of Cushion Design; Special Projects Consultants, Inc.; Mustin; AD-674 981

Flip: Floating Instrument Platform; Scripps; Bronson and Glosten; AD-675 216

METHODS AND EQUIPMENT

Layout and Design Considerations of RS-8 Control Consoles; Psychological Research Associates, Inc.; Barker and Older; AD-675 268

Non-Contact Head Development; Ampex Corp.; Branger; AD-675 046

Some Recent Developments in Reliability Theory; Calif. U.; Barlow; AD-675 034

MILITARY SCIENCES

Multi-Class Inventory Models Which Demand a Function of Inventory Level; Decision Studies Group; Iglehart and Jaquette; AD-675 286

A Modified Simplex Algorithm for Solving the Multi-Commodity Maximum Flow Problem; Geo. Wash. U.; Boyer and Hunt; AD-675 822

An Evaluation of Investment Criteria; Geo. Wash. U.; Sutton; AD-675 952

An INSURV/IEC Dictionary; Geo. Wash. U.; Hamilton; AD-675 953

An Algorithm for Universal Maximal Dynamic Flows in a Network; Geo. Wash. U.; Wilkinson; AD-675 954

NAVIGATION, DETECTION, COMMUNICATIONS, AND COUNTERMEASURES

Target Detection Performance with Sonar Displays of Different Sizes; Human Factors Research, Inc.; Baker *et al;* AD-675 810

Intelligibility of Speech Signals Spectrally Compressed by a Sampling-Synthesizing Technique; Ohio St. U.; Takefuta *et al;* AD-675 689

World-Wide VLF Effective-Conductivity Map; Westinghouse Electric Corp.; Morgan; AD-675 771

Processing of Data From Sonar Systems; General Dynamics Corp.; Kanefsky *et al;* AD-476 591

PHYSICS

Pulse Shapes of Creeping Waves Around Soft Cylinders; Catholic U.; Uberall *et al;* AD-675 055

Critical Field Ratio Hc3/Hc2 for Pure Superconductors Outside the Landau-Ginzburg Region. T Approx. O Deg. K; Md. U.; Hu and Korenman; AD-675 051

Sublattice Magnetization of Several Rare-Earth Iron Garnets; Duke U.; Myers *et al;* AD-675 392

A Theoretical and Experimental Investigation of the Compressible Laminar Wake Behind a Long Slender Cylinder; Calif. U.; Au and Berger; AD-674 963

On the Oscillatory Instability of a Differentially Heated Fluid Loop; Woods Hole; Welander; AD-675 348

Relaxation in Gas-Particle Flow; Purdue; Rudinger; AD-675 500

Cross Sections for the 160 (Gamma 2n), 19F (Gamma, 2pn), 27A1 (Gamma, 2pn), 51V (Gamma, Alpha), and 51V (Gamma, Alpha3n) Reactions to 300 MeV; Ill. U.; Meyer *et al;* AD-674 879

Electron Scattering Studies of Calcium and Titanium Isotopes; Stanford; Frosch *et al;* AD-675 038

Use of Polarized Photons as a Parity Filter in Vector-Meson Photoproduction Experiments; Harvard; Cooper; AD-675 307

Quark Models, Current Algebras, and Radiative Corrections to Beta Decay; Harvard; Callan, Jr.; AD-675 311

On Perturbation Expansions for Real-Time Green's Functions; Md. U.; Korenman; AD-675 049

Electrical Resistivity and Thermoelectric Power of CuAu Alloy; Calif. U.; Tachiki and Teramoto; AD-674 964

On Stress Waves in Viscoelastic Media Conducting Heat; Nortwestern U.; Achenbach *et al;* AD-675 015

A Magnetic Study of Color Centers in Alkali Halides; Oregon St. U.; Scott; AD-674 872

Amplified Ferrimagnetic Echoes; Lockheed Missiles and Space Co.; Kaplay *et al;* AD-674 965

Dielectric Properties of the Wigner and Related Dipole Lattices; Calif. U.; Bagchi; AD-675 036

Electrical and Mechanical Relaxation in CaF2 Doped with NaF; Utah U.; Johnson *et al;* AD-675 058

Rotational Excitations in Solid D2; Duke U.; Ramm *et al;* AD-675 393

Principles and Applications of Praetersonics; Stanford; Bahr *et al;* AD-675 788

Numerical Solutions of the Scalar Helmholtz Equation; Houston U.; Boyd, Jr. and Childs; AD-675 945

Evaluation of the Acoustic Response of an Air-Water Siren; Houston U.; Mitchell and Muster; AD-675 946

Numerical Values of Acoustic Surface Wave Velocities; Georgetown U.; Mayer and Lamers; AD-675 971

The Dielectric Relaxation Spectra of Water, Ice, and Aqueous Solutions and Their Interpretation. Ice I as a Photon Dielectric; M.I.T.; von Hippel; AD-676 202

Experimental Determination of Wave Resistance of a Ship Model From Lateral Wave-Slope Measurements; Webb Inst. of Naval Architecture; Ward; AD-675 820

Forces Due to Gravity Water Waves on a Long Vertical Circular Cylinder; Webb Inst.; Ward and Snyder, III; AD-675 821

Experimental Studies to Establish Scaling Laws for Modeling Cavitation Damage Intensity; Hydronautics Inc.; Kohl; AD-675 939

Stability of a Pure Electron Plasma in Cylindrical Geometry; Iowa U.; Knorr; AD-676 201

Stationary Anode-Adjacent High-Field Domains in Cadmium Sulfide; Delaware U.; Boer and Voss; AD-675 664

Internal Friction Peak in Iron Due to the Dragging of Dislocations by Interstitial Impurities; Columbia U.; Agarwala and Beshers; AD-675 665

PROPULSION AND FUELS

Circumferential Modes of Vibration of a Model for a Solid-Propellant Rocket; Northwestern U.; Achenbach and Chou; AD-675 025

Dr. Martin E. Glicksman, Metal Physics Branch, Metallurgy Division, Naval Research Laboratory was one of the ten recipients of the Twenty-First Annual Arthur S. Flemming Awards. At the presentation it was noted that Dr. Glicksman's contributions were to the field of metallurgy in the areas of solidification and crystal growth.

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USNS MIZAR Finds USS SCORPION

On 30 October Navy scientists of the Naval Research Laboratory (NRL) on board the USNS MIZAR located portions of the hull of the USS SCORPION in about 10,000 feet of water approximately 100 miles southwest of the Azores. On 31 January the Navy announced that the Court of Inquiry charged with investigating the loss of the nuclear powered submarine USS SCORPION has concluded that, "the certain cause of the loss of SCORPION cannot be ascertained from any evidence now available." Thousands of underwater photographys were taken of the wreckage from USNS MIZAR. Later this year the deep diving submersible Trieste II will proceed to the location of SCORPION where on-the-spot observation and additional photographs can be made.

The MIZAR's pecular qualities and spaces, coupled with the scientific equipment and instruments, made the ship unusually well qualified to search the ocean floor for the SCORPION. In 1964 the MIZAR was the first ship to locate and photograph the remains of the USS THRESHER in 8,400 feet of water off the Massachusetts coast. The MIZAR team also played a key role in the search for the lost nuclear device off Palomaris, Spain, in April 1966.

Designated an oceanographic research ship (T-AGOR), the MIZAR started its career as a polar supply ship with an icebreaker type bow and a cruiser type stern and ice station controls mounted in a tower near the box. Outwardly she has changed little. The cargo booms amidships have been replaced by a large trapazoidial house called the wellhouse. However, internally many changes have been made. There is now a large hole in the bottom of the MIZAR extending from her main deck down through her hull. The house covers this hole which is then covered at deck level by two hydraulically operated doors. The cargo hold now contains large reels of heavy cable and line instead of the Arctic supplies it once carried. Other cargo spaces have been converted into quarters for the scientists, a photo lab, an electronics lab, an electronics technician's shop, a navigational aids room and a control center. Completely air conditioned, the spaces are never empty as the scientists work in two teams, each team working 12 to 14 hours a day.

Designated BLUE and GOLD as are the Navy's Polaris submarine crews, the work day is divided logically along the meal-time hours. On the SCORPION mission, the BLUE team, headed by Senior Scientist Chester Buchanan, who is head of NRL's Ocean Engineering Branch, worked from midnight to 7 a.m. and from noon to 5 p.m. The GOLD team, headed by Research Physicist Robert B. Patterson, works the other 12 hours. Both these men are Naval Research Laboratory employees as were nine more of the scientists. The Naval Oceanographic Office provided the other four scientists who round out the 13 man scientific team. Along with Captain Hobbs and his 40-man crew, they comprised the MIZAR team which left Norfolk, Virginia, on June 2, to search for the SCORPION.

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FLIP, which is a floating laboratory, will be deployed into the BOMEX area. See page 10.

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