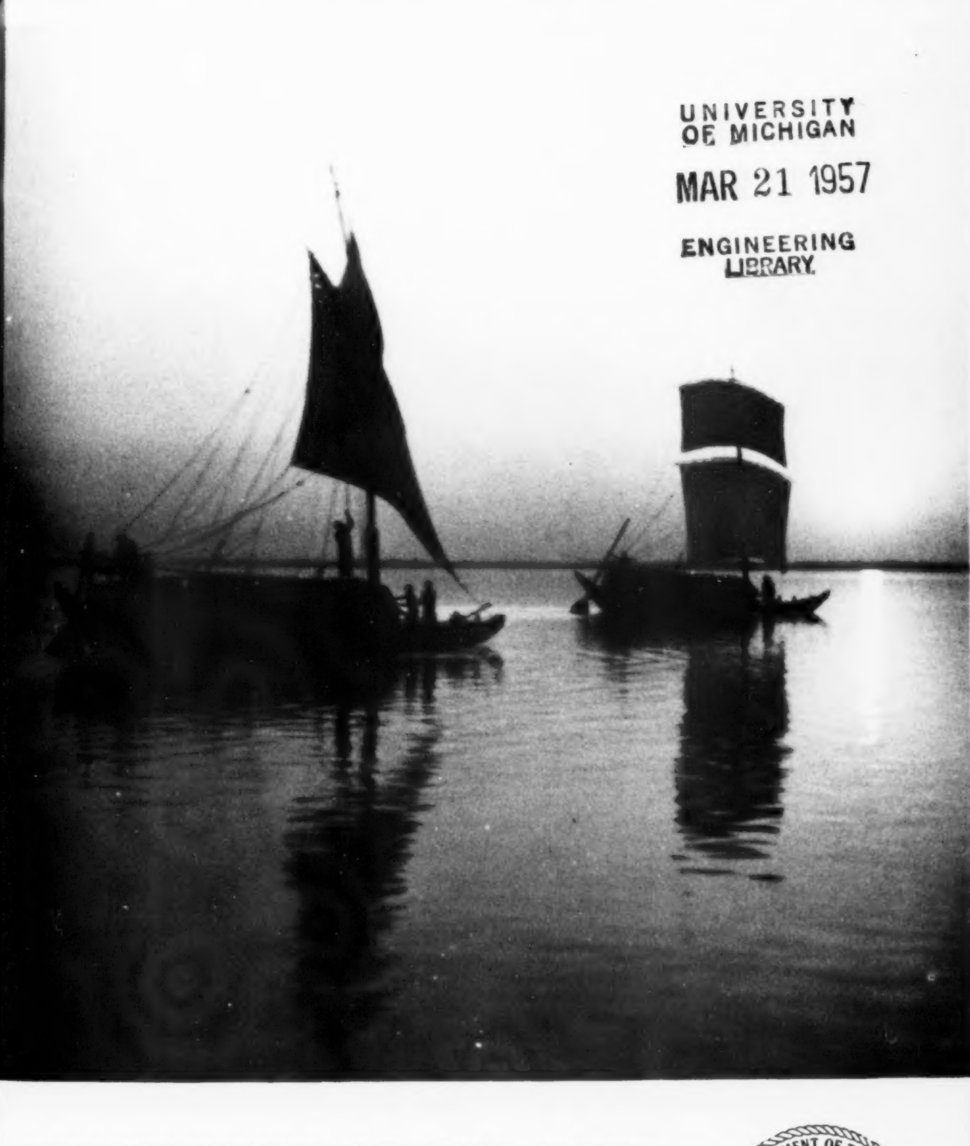
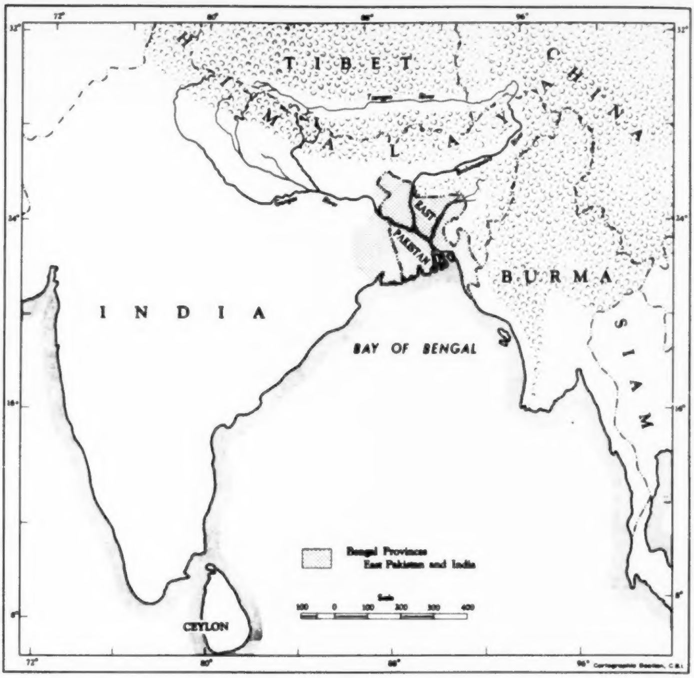
OFFICE OF NAVAL RESEARCH MARCH 1957

RESEARCH REVIEWS



DEPARTMENT OF THE NAVY
WASHINGTON, D. C.



Regional map of East Pakistan and adjacent areas.

Geological Studies in the Bengal Delta

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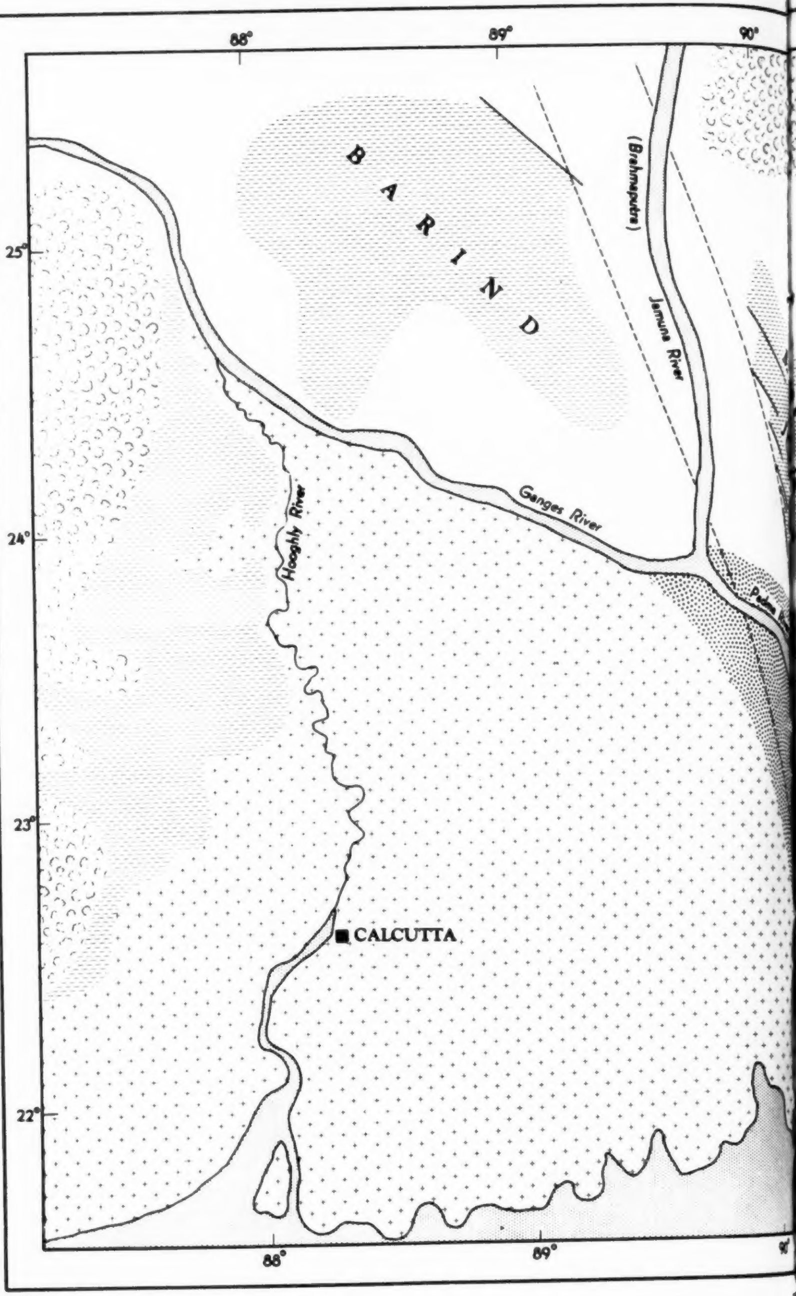
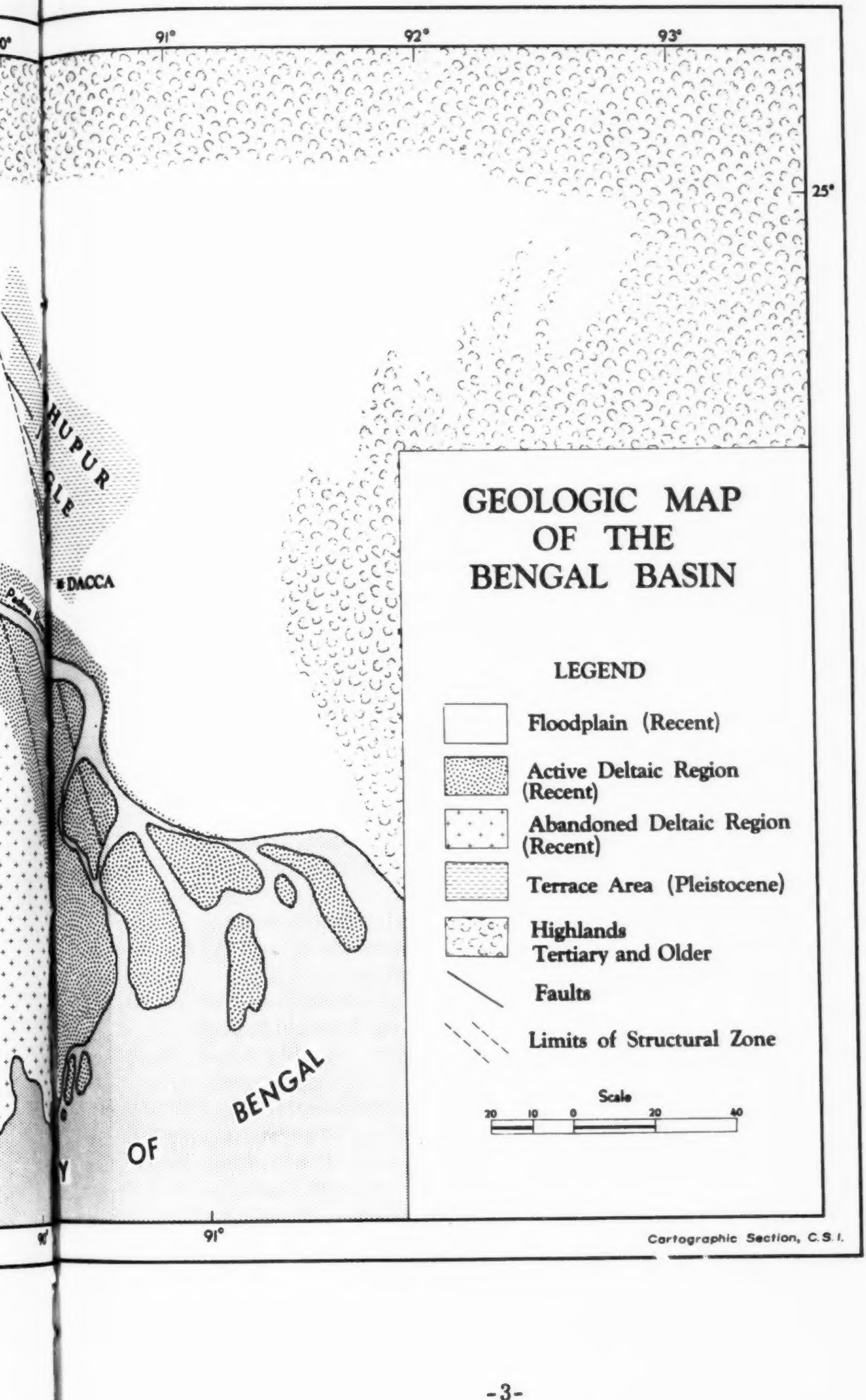
The Coastal Studies Institute of Louisiana State University has been conducting geological studies of low coastal regions for several years under the sponsorship of the Office of Naval Research. A prominent part of the study has been concerned with trafficability and navigability of the Mississippi River delta region, which comprises nearly a third of the State of Louisiana. Recently an opportunity arose for the writers to spend a field season in the provinces of Bengal in East Pakistan and India through the courtesy of the University of Dacca in East Pakistan and the Geological Survey of India. The purpose of the study was to compare the Mississippi River delta with the grandfather of deltas—that of the combined Ganges and Brahmaputra Rivers—which comprises most of the Bengal provinces. These two rivers, which drain both the north and south flanks of the mighty Himalaya Mountains, are each about the magnitude of the Mississippi River in water volume and sediment load.

Motor launch and crew used for field work in the Bengal Delta. Note pottery water jugs and cook stove on stern.

Even though the Bengal delta is similar to the Mississippi River delta in many respects, conditions for field work are very different in the two areas. Whereas roads, bridges, and ferries are an accepted part of the American scene, the maze of rivers in Bengal provides the principal routes of communication. Most field work must be done with slow, ungainly, man-and-wind-powered "country" boats (see cover), but occasionally motor-driven launches are available. Several months were spent in a continuing search for a motor launch capable of serving as field quarters in some of the remote areas. The 35-foot launch finally obtained was similar to those used in America, except for the crew required, which consisted of a driver, engineer, anchor man, cook, helper, and the inevitable sweeper, all performing the duties normally handled by one man in America. A crew of six, plus interpreter and necessary field equipment, all crowded on a 35-foot launch, left little room for the two writers, let alone the luxuries of life, such as sleeping accommodations. Vehicular transportation on the few roads that exist in the region generally consisted of ox-carts (top speed, 1.5 miles per hour) or rickshaws (top speed, 3-5 miles per hour, depending upon the size and energy of the native operator). Walking was usually found to be both faster and more enjoyable.

The Ganges-Brahmaputra delta complex can be arbitrarily subdivided into two portions: the region of major annual overflow with resulting sedimentation, and the older abandoned deltaic portion not so affected (see geologic map). Field work was carried out in both areas, usually with a large and attentive, though uncomprehending, audience.


88°
89°
90°
25°
24°
23°
22°
B A R I N D
(Brahmaputra)
Jamuna River
Ganges River
Hooghly River
Padma
CALCUTTA
DACC
HUPU
LE


91°
92°
93°
25°
HUPUR
GLE
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BENGAL
OF
Y
90°
91°
GEOLOGIC MAP
OF THE
BENGAL BASIN
LEGEND
Floodplain (Recent)
Active Deltaic Region (Recent)
Abandoned Deltaic Region (Recent)
Terrace Area (Pleistocene)
Highlands Tertiary and Older
Faults
Limits of Structural Zone
Scale
20 10 0 20 40
Cartographic Section, C.S.I.

Bicycle rickshaws furnish transportation on the few roads of Bengal.

Hand-auger borings are made to test sediment properties. Even in isolated regions an audience always assembles.

The abandoned deltaic region flanking the Bay of Bengal is known as the Sundarbans Jungle. It consists of a dense mangrove-type swamp covering about 3,000 square miles. Considerable work was done in the Sundarbans tracing the old, abandoned Ganges River channels. In dramatic contrast to the rest of East Pakistan, the area is uninhabited and is utilized solely as a government forest preserve. Water suitable for drinking is not available in the jungle and, therefore, must be carried in. This became a serious problem for our overcrowded launch (note large pottery water jugs on the deck in the photograph of the launch). Hundreds of years ago, however, the abandoned streams were carrying fresh water, which made possible human habitation in the region. Many ancient cities were found and explored along the tidal channels of the jungle. Most of the cities are now rubble, partly buried with tidal and deltaic sediments, but one temple was found still standing. Charcoal, bone, and ash were collected from old habitation sites in order that carbon-14 age determinations might be made. It is hoped that these datings can be used to decipher major river changes and ultimately establish a chronology for deltaic development in Bengal.

The Sundarbans Jungle, beside being an interesting deltaic region, is also the home of the well known Bengal tiger. During the year 1955 more than 50 native woodcutters and forest guards were lost to these man-eaters. The presence of huge, fresh paw marks in the soft tidal mud of the dense jungle put us constantly on the alert while studying the area.

Ruined temple of abandoned city in the Sundarbans Jungle.

W. G. McIntire collects charcoal from old habitation site. Radio carbon dating will give age.

Our scientific interest was somewhat dampened one day when a native woodcutter was killed by a Bengal tiger in the area in which we were working. His friends did not touch his body. Instead, they surrounded it with a temporary bamboo fence which had a shotgun trap arranged at the entrance. When the killer returned to finish his meal he triggered a silk cord tied to the shotgun and was killed. The skinned hide measured nearly 13 feet from head to tail. After this experience, even a 12-gauge shotgun seemed minor protection in the dense jungle where it was often impossible to see more than a few feet in any direction.

The Bengal provinces serve as an excellent laboratory for deltaic studies in that the British government during the period 1770-1776 sponsored a detailed mapping program by Major James Rennell. The resulting planimetric maps, unusually good for the period, make possible comparisons which show deltaic changes during the intervening 175-year period. These maps reveal not only the expected river changes and modifications, but also another rather startling fact. The active, or eastern, section of the Ganges-Brahmaputra delta has not been building seaward into the Bay of Bengal for the past 175 years at anything like the expected rate. The delta seaface, although quite different in details on the older maps, has not extended itself seaward through creation of new land, despite the enormous quantity of sediment carried by the rivers. This fact becomes even more curious when it is noted that the western part of the delta, now abandoned by the Ganges and not actively receiving deltaic sediments, seems to have had no difficulty building seaward during an earlier period. In contrast, the present active deltaic section, although receiving an enormous sedimentary load, is today a coastal embayment (see geologic map).

There are two obvious ways in which the lack of build-out of the active delta can be explained. The first possibility is that the high tides and currents of the Bay of Bengal are sweeping the sediment seaward into deeper water. The second possibility is that the active delta is subsiding as rapidly as sediments can be dumped into the region by the compound river system.

The former explanation is difficult to accept because there is no evidence that the high tides and strong currents have had any appreciable effect upon the abandoned Sundarbans deltaic area, which adjoins the active delta on the west. It might be expected that the coast of the abandoned delta would subside and retreat rapidly after the river moved eastward and ceased depositing material there, as has occurred in the Mississippi River delta region. Borings in the abandoned delta, however, show that though subsidence has occurred, the tidal deposition of sediment has been able to keep pace with it and has maintained the land surface at the approximate level of high tide. It is unlikely then that tides and currents move much of the sediment to deep waters, but they do appear to redistribute material along the coast itself.

The second alternative is that subsidence in the active delta is keeping pace with sedimentary deposition by the combined Ganges-Brahmaputra River system. Although subsidence due to sedimentary compaction is known to be an effective factor in the Mississippi delta and other regions, it is not likely that it is the only reason the Bengal delta is unable to extend itself seaward. Another reason may be that active structural subsidence is occurring in at least part of the region.

Field and laboratory work have indicated the probability that a major trough or zone of weakness follows the trend of the present course of the Brahmaputra River, at least from the latitude of the Shillong plateau southward to the active delta. Both direct and indirect evidence suggest such a zone.

Direct evidence of a sinking trough exists in the form of a series of faults—breaks in the surface crust of the earth along which one side has moved up and the other side down. A series of six staggered or "en echelon" faults separates the low valley of the Brahmaputra River from the uplifted older sediments of the Madhupur Jungle (see geologic map). At least one fault forms part of the boundary between similar uplifted older sediments of the area called the Barind and the west side of the Brahmaputra valley. Thus the Brahmaputra valley, which extends southward through Bengal, seems to be a rapidly sinking trough.

Indirect evidence confirming the presence of this trough can be obtained by comparing the older maps of Rennell with modern maps. This comparison shows that numerous changes have occurred in river courses. Many streams which formerly discharged south into the Ganges now are discharging in an easterly direction into the Brahmaputra. The Brahmaputra River itself has shifted its course from the east to the west side of the Madhupur. The most important river diversion took place a hundred or so years before Rennell mapped the region, when the trunk stream of the Ganges abandoned the Hooghly River channel and the western delta region for its present course, which leads it into the Brahmaputra trough. This change has had a serious effect on the major port city of Calcutta, which has been and is faced with the difficult problem of maintaining navigable channels to its port facilities.

There can be little doubt that structural activity in the low-lying Bengal Basin is associated, in a way not yet completely understood, with some of the earth's mightiest mountains, including the nearby Himalaya and the southerly trending chains to the east. It is generally agreed by geologists that these mountains are still rising at a rapid rate, as evidenced by frequent and violent earthquakes. It should be expected, then, that nearby troughs and coasts are subsiding at a rate which prevents seaward growth of major deltas. A state of balance in the earth's crust is being maintained by the uplift of rocky mountainous areas from which material is being removed and the sinking of adjacent regions where that material is being deposited.

Flight Trainer To Have Quick-Thinking "Brain"

The first Universal Digital Operational Flight Trainer (UDOFT) is being developed by Sylvania Electric Products, Inc., Waltham, Mass., under a contract of more than a million dollars awarded by the Naval Training Device Center of the Office of Naval Research, Port Washington, N. Y. The UDOFT program is jointly sponsored by the Navy and the Air Force.

A new quick-thinking electronic "brain" will be used in the UDOFT trainer to simulate a wide variety of aircraft, including the most recent supersonic jet fighters. The UDOFT is expected to provide the additional speed and versatility in ground training devices needed in simulating the characteristics of the growing number of supersonic planes which U. S. pilots will be flying. The system is centered around a new large-scale digital computer of great flexibility, speed, and accuracy. The computer will make it possible to shift from the simulation of the flight of one plane to the flight of another, as well as to change flight conditions, or aerodynamic characteristics, to test their effects on the flight of the simulated plane and the response of the pilot.

In the operational flight trainer, the pilot sits in an actual airplane cockpit, as he would in flight. His controls and instruments are connected with floor-to-ceiling banks of computing and other electronic equipment next to the plane section. When the cockpit canopy is closed, the trainee can see only the instruments and controls with which he would operate the plane if it were in actual flight.

Although the cockpit itself does not move, the electronic "brain" simulates flight by setting appropriate readings on the instruments. The trainee's teacher has a duplicate set of instruments and controls at the computer panel, from which he can determine what the trainee is doing. He can also introduce new conditions like engine failure, air turbulence, and storms, which the electronic "brain" translates into appropriate readings on the cockpit instruments.

According to Mr. Richard M. Osgood, manager of Sylvania's Waltham laboratories, the UDOFT computer eventually will be able to solve equations for several cockpits simultaneously, allowing a group of trainees to receive simultaneous instruction, either in independent flight, in flight formations, or in simulated combat.

ONR and National Security*

ADM A. A. Burke
Chief of Naval Operations

The United States Navy has traditionally been a great contributor to science. Since the industrial revolution brought steam and steel to ships, our Navy has been in the forefront, adapting the new advances of each period to its needs. The requirements the Navy has generated have in turn stimulated and encouraged scientific growth throughout the United States.

The great boost to scientific and technological growth provided by World War II ushered in a new period. More than ever before national defense became a function of scientific progress. The continued solution of our pressing security problems clearly lay in pushing outward the frontiers of knowledge—in finding new areas for technological development.

The Office of Naval Research and the Naval Research Advisory Committee were established just after World War II to meet these new requirements. ONR immediately activated vigorous programs in support of basic research. It has since expanded into all areas of scientific endeavor.

The advances which have come through ONR have benefited not only the Navy and the Army and Air Force but the entire civilian economy as well. Boundary layer control, vertical-rising aircraft, nuclear power, computers, printed circuits, and transistors are only a few examples of the advances which have had widespread application. No finer testimonial can be given to ONR's accomplishments than the prominent role it has assumed in the space-satellite program.

The success of this Office has been due in large measure to the vision and hard work of the individuals who founded it and who have guided it during these past 10 years. Another factor in making the achievements of the past 10 years possible has been the successful policies developed jointly by ONR and NRAC. These policies have provided a sound basis for both government and privately-sponsored groups to work effectively together.

The scientific and technological progress made during the last decade has had a profound effect on our national security. Our armed forces have great new capabilities. New tactics have been developed to employ new weapons systems. But of even more significance, a fundamental change has taken place in warfare, and it is imperative that we recognize it. This change is the reintroduction of an element which has been largely absent in modern warfare—the element of restraint.

We are at the point where nations have finally achieved what might once have been considered a guarantee of national security—the

*Condensation of an address given at ONR's Decennial-Year Banquet, February 8, 1957.

destructive power to annihilate an opponent. But we now see that this capability in itself is not a guarantee to security but only a deterrent to its own use by either side. The present overwhelming disparity between offensive and defensive capabilities has eliminated any expectation of gain from unrestrained warfare. No nation or group of nations possesses the resources to purchase an effective defense against the destructive power of its potential enemies. No matter how effectively an attack may be executed, the retaliation that would be visited upon the aggressor nation would mean its doom. This is true today when delivery vehicles are predominantly aircraft. It will only become a more obvious truth when missiles reach their full potential as delivery vehicles. Unrestrained warfare has been reduced to an act of desperation—a last resort after hope is abandoned and gain forsaken.

Deterrent power, which makes big war unlikely, is one of the essential requirements of our defense posture. But deterrent power is not employable power; its value lies in its not being used. Meanwhile, we must face the continuing problem of small wars—how to keep them from starting, but if started, how to keep them small. Thus, if we are to have an alternative to megaton warfare, we must maintain an adequate source of employable power. We must insure that a large enough share of our resources—material and scientific—is devoted to the forces and weapons which are capable of controlling warfare without expanding it.

The advances that have come through ONR in the past decade have all pointed toward a fuller exploitation of the seas, toward increased effectiveness of our naval forces in controlling the seas and in projecting the full range of free world power from the seas. These advances are all solidly built on our old capabilities, fully integrated, fully employable.

The Navy's investment in science underlines the Navy's faith in the future. We have only begun to develop the potentialities of sea-based forces. The whole future lies ahead of us. We will continue to look to ONR and through ONR to the scientists of America for the new ideas which will shape the fleets of the future. We have our short-term plans, and we know our long-range objectives. We have no idea what the fleet of the 21st century will look like. But our investment in science assures us that, just as today, it will be an effective force employing the most modern weapons of its day, and capable of any action our nation requires of it.

NTDC In a Nutshell

The Naval Training Device Center at Port Washington, New York, has officially adopted a slogan—TOOLS FOR MORE EFFECTIVE TRAINING. In five concise words the slogan summarizes the Center's mission—research, development, production, installation, and field support for training aids and devices as requested by the Navy's training agencies responsible for all Fleet training.

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Physics of the Earth's Magnetic Field

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It is a commonplace that scientific investigation, even of a rather "pure" type, takes unexpected turns and leads to new insights and oftentimes practical results. When nearly 20 years ago the writer made his first speculative and seemingly hopeless efforts to peer behind the mysteries of the earth's magnetic field, he had not the least inkling that years later he would find himself joining hands with many other scientists to help develop a new branch of hydrodynamics. This branch, known as "magneto-hydrodynamics," or "hydromagnetism," deals with fluids and gases that are good conductors of electricity.

If an electric current flows in such a fluid or gas, the current being accompanied by a magnetic field, there arises the problem of what the fluid motion does to the electromagnetic field, and, conversely, how the presence of the field modifies the motion. We know that by relative motion of electrical conductors a magnetic field associated with one wire can produce an electric current in another wire; this is the principle of the conventional generator. We know also that two current-carrying wires will exert mechanical forces upon each other; the operation of electric motors is based on this principle. But in magneto-hydrodynamics one studies more complicated systems; that is, in place of a fixed-field magnet and a rotating armature we have continuously deformable conducting media throughout. Electric currents induced in these media will, by way of their magnetic fields, exert mechanical forces upon the media. The study of these forces is within the scope of so-called classical physics, but like so many similar studies, it was not pursued persistently until recent years.

Magneto-hydrodynamics is of major importance in two main realms of science and engineering.

Investigations carried out in one of these realms have to do with the control of fluid motions and gaseous discharges by means of magnetic fields. Thus the flow of coolants in nuclear reactors has of late received much attention from the standpoint of magneto-hydrodynamics. Quite recently the Russians published claims to the effect that extremely high temperatures can be produced in gas discharges by constricting them magnetically; they indicate that thermonuclear reactions might be approached in this way, a claim that is now being closely scrutinized by our own nuclear physicists.

The second realm in which magneto-hydrodynamics is important is geophysics and astrophysics. Direct observation has shown that all sunspots contain magnetic fields. Fields that occur in the dark areas of the larger sunspots are of the order of 2,000-3,000 gauss. If we consider that a large sunspot covers an area of perhaps a thousand times

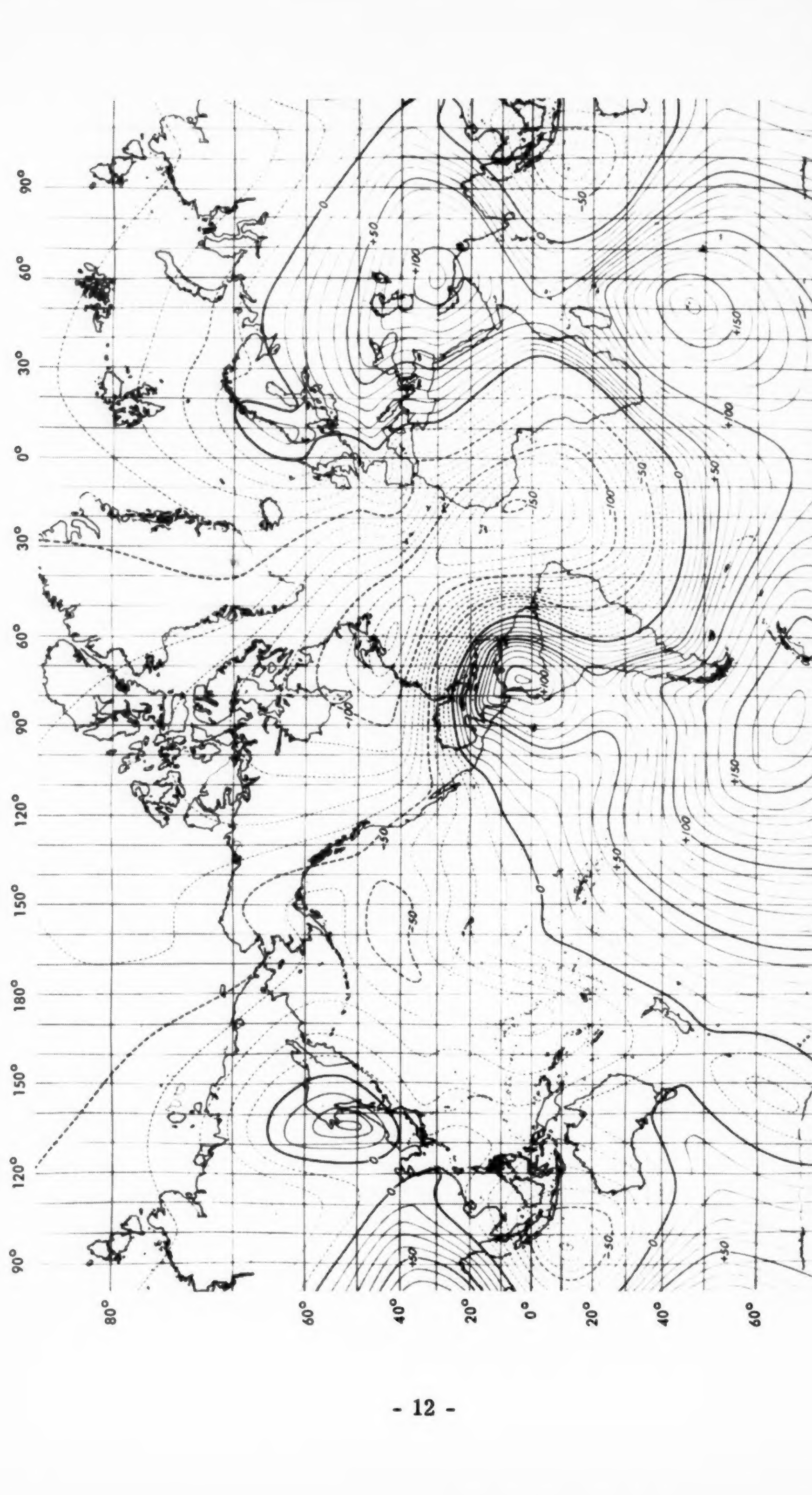
*The author recently joined the staff of the Scripps Institution of Oceanography as a research physicist.

the earth's surface, it becomes evident that the stars have very powerful devices indeed for the generation of electromagnetic energy. Magnetic fields also exist throughout the rest of the sun's atmosphere. These fields are of the order of a few gauss, a slightly higher value than that typical of the magnetic field at the earth's surface. In disturbed regions of the sun—often indicated by the appearance of stronger magnetic fields and sometimes by sunspots—there occur corpuscular emissions from the solar surface into space. Ionized solar matter consisting mostly of protons—that is, hydrogen nuclei—and of an equal number of electrons, which make the gas as a whole electrically neutral, is ejected. This gas is an excellent conductor of electricity, and as it migrates into space it carries internal electric currents and their magnetic fields with it. When the earth happens to traverse such an extremely tenuous stream of matter, usually occupying a region of space much larger in size than the earth itself, the electric currents in the gas interact with the electrically conducting envelope of the earth—the ionosphere—producing what is known as a magnetic storm. The practical importance of magnetic storms is that they interrupt radio communication. Although this subject is extraordinarily complex, it has recently shown signs of yielding to theoretical analysis.

The writer and his associates and students have for some years been concerned with the interpretation of the earth's magnetic field in terms of magneto-hydrodynamics in order to elucidate the nature of magnetic storms. To understand that such an enterprise might have some hope of success, one must first realize that not all of the earth's interior is solid. The solid part—the so-called mantle—surrounds the liquid core, whose diameter is roughly half of the earth's diameter. Most geophysicists believe that this liquid core consists in the main of molten iron that probably contains some impurities. We thus have just the right setting for the appearance of hydromagnetic effects, namely, a mass of liquid which, being mainly iron, is a good conductor of electricity.

But in order that such effects may appear it is necessary that the liquid be in motion. The effects, then, are essentially the same as those produced by electric generators and motors—the motions of parts of the metal mass of the core relative to each other set up currents, and the currents set up forces which modify the motions. The explanation of the earth's magnetic field in terms of these effects is known as the dynamo theory.

Now, how about these motions? Fortunately, we have direct evidence for them—the familiar vagaries of the magnetic needle. As every navigator knows, secular variations of the earth's magnetic field require the redrawing of magnetic maps every 25 years or so. One can propound some quite convincing arguments to the effect that these variations do not arise in any part of the solid earth but have their origin in the liquid core. The best basis for such arguments is the monumental analysis of geomagnetic data carried out by E. H. Vestine about 10 years ago. These data, which were obtained during the first four decades of this century, comprise not only the records of geomagnetic observatories, but also the vast body of observations gathered by the research vessels of the Carnegie Institution. The accompanying map, taken from Vestine's work, gives an idea of the way this information may be summarized.



Geomagnetic secular change (gammas per year) in vertical intensity, epoch 1922.5.

The data plotted do not refer to the field itself, but to the rate of change of a field component, in this case the vertical component of the field vector. The curves drawn are lines of constant rate of change—solid for positive, broken for negative changes. The typical changes are of the order of 0.5-1.5 thousandths of a gauss per year. Inasmuch as the over-all vertical component of the field is only 1 to 2 tenths of a gauss, the over-all field changes rather radically in the course of about a century. Actually, the "hills and dales" of the map migrate and change their shapes quite rapidly; thus two maps made 30 years apart look substantially different. As a result of this the actual variation of the magnetic field at any one place does not as a rule exceed a few percent of its mean value.

Now to the interpretation of these remarkable effects. We must think of the motions in the core as being full of large-scale eddies, and of the "hills and dales" of our map as translating the structure of these eddies into a magnetic language, as it were. As the conducting fluid of the core moves across the lines of force of the earth's main magnetic field, secondary electric currents are induced in it which give rise to the detailed features that appear on the map. This interpretation has been quantitatively elaborated not only by the author's group but also by Dr. E. C. Bullard in England, and it is now well established. We can readily obtain information about the magnitude of the fluid velocities in the core from the rate at which the lines of constant intensity or constant deflection in our magnetic maps move over the surface of the earth. A more detailed analysis reveals that the average velocity of the molten iron in the core is 0.3 millimeters per second (nearly a hundredth of an inch per second, or about 25 yards per day).

The question which now arises is, of course, what makes the core move? There can be little doubt that we are dealing here with some sort of convection; the pattern is not at all what we could expect from, say, a tidal motion. Perhaps the best explanation is that derived from the theory of Professor H. C. Urey of the University of Chicago. According to this theory, very, very slow activities, such as chemical changes and crystallizations, have been going on in the earth since its beginning. These activities, which are proceeding so slowly they have not yet been brought to completion, may supply the energy for the convective motions.

The next step is to see whether the entire magnetic field of the earth can be explained in terms of fluid motions that maintain the field after the manner of a rotating generator. This problem has been studied mathematically by the author and his associates and by investigators in Japan and England, and the work is now well advanced. In solving the problem one must explain how the complex connections in the technical machine are duplicated by the complex patterns of fluid motion in the metallic mass of the earth's core. The genie in the picture is the deflective effect of the earth's rotation, known as the Coriolis Force. Without rotation of the earth there could be no hydromagnetic generator in the core. The deflective force of rotation twists the pattern of motion into complicated three-dimensional shapes.

The magnetic field inside the fluid core has, roughly speaking, a spiral structure; this field is much stronger and contains very much more energy on the inside than it does on the outside. Thus, the magnetic field that we observe at the surface of the earth is merely a trace, as it were, of much more powerful and extensive phenomena going on all the time in the earth's fluid core. The dynamics of such a large ball of conducting fluid simply cannot be understood without taking into account the magnetic effects that arise in it spontaneously. This view has been extensively confirmed by astronomical observations carried out by Dr. H. Babcock. They show very clearly that whenever convection as well as rotation (the two essential requisites of a fluid dynamo) are present in a star, there arise also intense magnetic fields; when even one of these motions is absent, the star shows no magnetic fields.

Now, an investigation of an object so remote as the earth's fluid core might well appear to some not only as academic, but also as highly speculative. Nevertheless, whenever phases of the investigation have had points of contact with phases of geophysical and astronomical investigations for which observational data have been obtained, our theoretical notions have been confirmed. For example, through the study of rock magnetism, or "fossil" magnetism, as it is often called, evidence has been gathered to the effect that the polarity of the earth's magnetic field has not always been the same in the geologic past as it is now. While the study of rock magnetism is not new, it has in recent years aroused the curiosity of a number of distinguished investigators both here and abroad, and extensive results should soon be forthcoming. At present we cannot yet assert beyond any doubt that the earth's field has reversed itself, but there is a very good chance that it has, and perhaps many times. The dynamo theory seems ready-made to explain such a phenomenon. In a self-sustained generator of electrical current the polarity depends on the direction of a small initial field from which the sustained internal field builds up. It may be shown that when the convective motions in the core either die down temporarily or become greatly intensified for a short period, a reversal of the magnetic polarity can result. When such changes occur, the magnetic pole does not wander over the surface of the earth but disappears gradually and reappears with opposite polarity. A quantitative analysis of the magnetic secular variation indicates that a period of about 2,000-4,000 years is probably required for a reversal to occur.

We have left for the end of this survey the problem of predicting future local changes of the magnetic field, such as are represented in the map. A glance at the map will show that the "hills and dales" are on the whole distributed rather irregularly. An associate of the author, Dr. K. McDonald, has indicated that these changes are perhaps not entirely without regularity, but that the hills tend to be strung out along chains or ridges. There is not enough of this order, however, to make it of practical value for the forecasting of future changes of the magnetic field. Inasmuch as the local variations of the magnetic needle represent essentially eddies in the earth's core, it is not surprising that these variations should be nearly as irregular as the weather. The very fact that we are only beginning to understand the mechanism of the earth's magnetic field will tend to make us somewhat skeptical about forecasting its variations.

ONR's Decennial-Year Symposium

Coordination of research has been a responsibility of the Office of Naval Research since its inception, and during the 10 years of its existence the Office has sponsored symposia and conferences on many subjects. "A Decade of Basic and Applied Science in the Navy"—the symposium to be held on March 19th and 20th as part of ONR's Decennial Year—is intended to acquaint the participants with the broad scope of scientific work in the Navy and with the specific programs of the different activities, as well as to provide the opportunity for informal interchange of information and ideas.

The program will consist of 11 sessions—3 unclassified and 8 classified. Papers to be presented at the unclassified sessions, which will be held on Tuesday, March 19th, are as follows:

OPENING SESSION

Introductory Remarks: RADM Rawson Bennett, USN, Chief of Naval Research; LT GEN J. M. Gavin, USA, Chief of Research and Development; and MAJ GEN J. W. Sessums, Jr., USAF, Vice Commander, Air Research and Development Command.

SESSION A—SURVEY OF NAVAL SCIENCE

Research Problems Associated with the Development of Sidewinder: H. A. Wilcox, Naval Ordnance Test Station.
Recent Developments in the Study of Ship Motions: M. St. Denis, David Taylor Model Basin.
The Nature of Radioactive Fallout: C. E. Adams, Naval Radiological Defense Laboratory.
Relation of Chemical Constitution to the Wetting and Spreading of Liquids on Solids: W. A. Zisman, NRL.
Solar Control of the Ionosphere: H. Friedman, NRL.
Magnetic Materials Development at the Naval Ordnance Laboratory: E. W. McKee, Naval Ordnance Laboratory.

SESSION B—SURVEY OF NAVAL SCIENCE

Basic Problems in the Dynamics of the Aircraft Arresting Gear: F. O. Ringleb, Naval Air Material Center.
Progress in Shock and Vibration During the Last Decade: E. Klein, NRL.
Design of Man-Machine Control Systems: H. P. Birmingham and F. V. Taylor, NRL.
The Standardization of Color Vision Testing: D. Farnsworth, CDR (MSC) USNR, Naval Medical Research Laboratory.
The Navy Tissue Bank: G. Hyatt, Naval Medical Research Institute.
Some Physiological and Pathological Effects of Acceleration Stress: B. F. Burgess, Jr., LCDR (MSC) USN, Naval Air Development Center.

The classified sessions, which will be held on Wednesday, March 20th, have the following titles: Session C, Medical and Psychological Sciences; D, Physics; E, Chemistry; F, Earth Sciences; G, Medical and Psychological Sciences; H, Electronics and Acoustics; I, Mechanics and Engineering; and J, Metallurgy.

The Importance

C. S. Thomas
Secretary of the Navy

Today progress takes another forward step—and not a small one. In man's enduring search for knowledge, for self-betterment, and for understanding of the world and the universe in which he lives, progress is measured not in quantum strides but in the imperceptible, painstaking, and seldom glamorous steps taken daily in laboratories and classrooms across the country. Progress begins in dreams, in ideas, and in searching questions. It is always rooted in hope, propelled by the urge to learn something that is new and to lift the curtain and peer beyond the mystery of ignorance that restricts our horizons.

Today we are privileged spectators as one such dream becomes a reality and commences work in our service—the Naval Research Laboratory's nuclear research facility.

It is very fitting that Washington's first reactor should be located at NRL where, for more than a quarter century, research and study to build a stronger nation have been accomplished. From this very productive and foresighted laboratory has come a steady parade of ideas, inventions, and developments which have benefited science, business, and industry and thereby the safety, health, and well-being of us all. And it is certainly true that the basic research performed here has helped to build the greatest Navy in the history of civilization.

NRL can be described as one of our nation's foremost idea factories and idea storehouses. Its performance for more than 30 years justifies this description. Here, for example, radar saw its birth, and new types and kinds of communication equipment were developed. Here, for the benefit of our nation, major discoveries in chemistry, physics, and metallurgy were made. Here, this very day, the problems of outer space are being intensively explored. In the years to come I am certain that the research performed by the nuclear reactor facility will likewise lead to important new ideas, developments, and to a great increase of our knowledge of nuclear physics and its application to many other scientific fields.

The Navy is exceedingly proud of its long and fruitful partnership with science. The seal of the United States Naval Academy at Annapolis in fact carries a Latin motto which has always reflected the Navy's

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*An address delivered at the dedication of the Nuclear Reactor Research Facility, Naval Research Laboratory, 15 January 1957.

sic Research to the New Navy*

attitude towards science: "Ex Scientia Tridens," meaning "From Knowledge Comes Seapower." At NRL, a unique team of naval officers and civilian scientists have worked harmoniously together in the building of a stronger and better Navy.

In this atomic, electronic, and supersonic age, it is increasingly true that seapower depends upon knowledge. If our country is to continue to grow and prosper, if our land is to be the land of opportunity for our children, if we are to preserve our own freedom and that of the free world, if we are to remain freedom's arsenal, the seapower exerted today by the United States Navy must remain omnipotent. Our Navy cannot hope to control the seas in the future as it does today if it does not vigorously pursue a forward-looking research program and apply the knowledge it gains to continued control of the seas.

To continue to perform its traditional function, the Navy, like our Army and Air Force, is finding itself increasingly mechanized and complex. Modern combatant ships such as the atomic submarine NAUTILUS, the guided missile cruiser BOSTON, or the mobile airbase FORRESTAL are exceedingly intricate. They represent the most complicated equipment and machinery ever assembled by man in a small space.

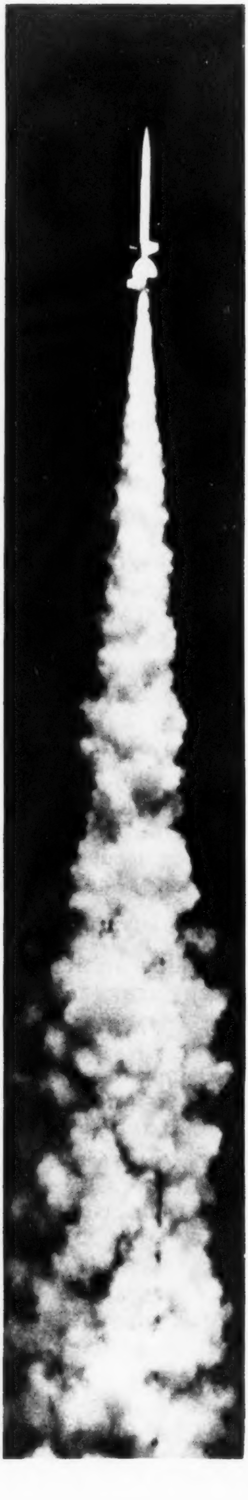
The contest between the free world and Communism will be won by the side which keeps the lead in scientific progress. Our country presently holds this lead and in my opinion will continue to do so. We rose to world power on our scientific genius and industrial progress. This position and this strength is directly dependent on a continued scientific progress in keeping ahead in such fields as missiles, aerodynamics, and nucleonics.

How can this be done? In only one way. By training sufficient scientists, by intensifying our research programs in every area, and by applying the resulting knowledge to the free world's progress.

That is why NRL is so important to our country. It makes an important contribution in the never ending accumulation of knowledge of our planet and the universe beyond. NRL also contributes powerfully in the field of applied research.

Let me give you a few examples of how basic research performed many years ago right here at NRL has since been converted to objects which protect our security and enrich our lives. Basic research performed by the Navy for example led to dozens of such everyday things as noninflammable hydraulic fluids, high-energy fuels, antifouling paints, synthetic paper, fire-extinguisher foam, synthetic lubricants, and radio crystals.

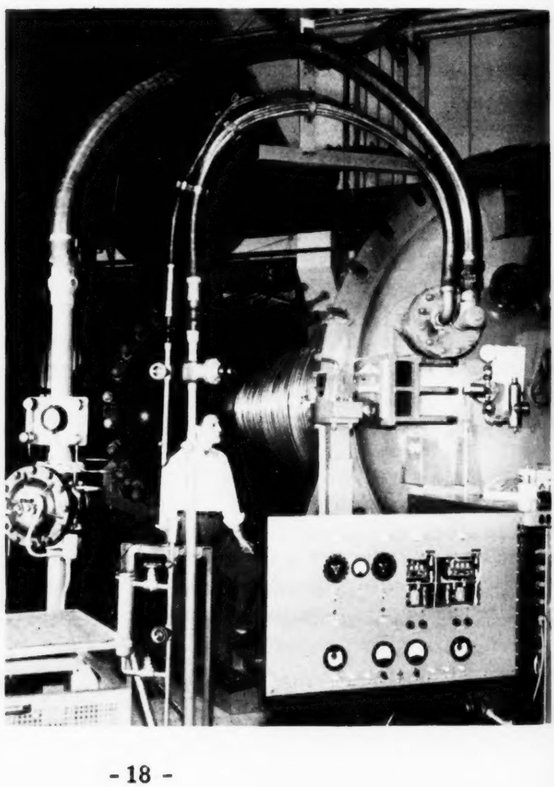
In regard to basic research which led to applications of naval significance, a few developments should be mentioned.



SONAR. NRL's sound barge

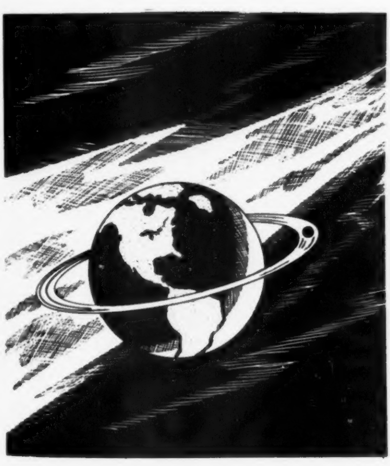
← UPPER ATMOSPHERE

NUCLEAR PHYSICS. NRL's 5,000,000-volt Van de Graaff accelerator



RADIO ASTRONOMY

VANGUARD



RADAR. NRL's flying radar laboratory

Radar is a prime example. Radar was born in this very laboratory. In 1922, two Navy civilian scientists, engaged in making radio fields measurements, observed that a ship steaming down the Potomac River and passing through the high-frequency field was detectable on their radio receiver. In 1930 it was noted that airplanes could be detected at a considerable distance by high-frequency radio communication apparatus. I need not remind this audience of the inestimable value of radar during World War II and its benefits to us today in the fields of aviation and sea commerce.

Another example is sonar. Statistics of the recent war show that 50 percent of all enemy submarines destroyed were sunk by sonar-equipped surface vessels. German Admiral Doenitz conceded that his Nazi U-boats had been defeated not by superior tactics or strategy but by American "superiority in the field of science." Much of the basic research of the propagation of sound waves in sea water was done here as many as 30 years ago. I might add that the greatest intensity and the highest priority is still placed here at NRL on studies which will help us defeat any future submarine threat. We are confident that the basic research of the oceans performed during the past decade will pay rich dividends in the future.

Still another example is nuclear physics. NRL is proud of the fact that it was the first U.S. Government agency to undertake the study of atomic power. This was done in 1939. In that year nuclear physics was still an academic curiosity which had little practical application except for painting radium dials on clock faces. Uranium was described in the encyclopedias of those days as "a metal of limited demand used principally in the ceramics industry." Scientists knew that theoretically a 2-pound lump of uranium the size of a golf ball could supply energy equal to 480,000 gallons of gasoline—but they knew no practical way of releasing it. So a vast amount of basic and applied research had to be done.

Indeed, the engineering miracles of World War II—sonar, radar, the proximity fuse, the rocket, the jet engine and the atomic bomb—each was made possible by basic research which was done many years before the war.

Presently, studies are being made in several vital fields. The U.S. Navy leads the world in radio astronomy. The huge 50-foot "dish" atop the administration building at NRL is the most precise instrument of its kind in existence today for studying radio signals from outer space. Studies in this field will undoubtedly lead to many new things tomorrow.

Next, there is the satellite program VANGUARD. Before many months a man-made satellite will be circling the earth at the altitude of a few hundred miles, making the circuit every 90 minutes. We can be sure that substantial and profound results will be forthcoming from this research.

Another vital area of research is the Navy's study of the upper atmosphere—the investigation of those electrically charged blankets of ions which enfold our globe and which are responsible for all long range

Secretary of the Navy C. S. Thomas (right) and NRL's Director P. H. Horn (left) look on as Mr. S. E. Golian, head of NRL's Reactor Branch, discusses features of the reactor pool.

radio transmissions; the mysterious cosmic rays from the sun, whose energy is millions of times greater than that which can be produced by nuclear fission. These are being intensively studied. Upper-air research is a field extremely important to the not-so-distant time when intercontinental missiles will be a reality, when man will fly through outer space, and to the time when manned rockets will circle the moon and perhaps conquer interstellar space.

And finally, what shall we learn from this new nuclear reactor? There is no way of predicting all that we will learn, but it will be used to study the structure of matter. It will be used to create and study new substances, to make chemicals radioactive for direct study, and to produce chemical and biological changes. In this reactor, radiation effects upon materials of all kinds—plastics, metals, cable coverings, transistors, and electronic components—will be studied. Shielding problems applicable to propulsion will be investigated. Some day this research may lead to nuclear power for trains and airplanes. All of this knowledge will lead to the quicker development of atomic power for peace and industry.

The Navy, therefore, is as aware of the urgent need for accelerated emphasis upon basic research to gain new knowledge, as it is anxious to reduce the elapsed time between basic research and production. Further, it is interested in basic research not just for perfecting and creating new weapons and countermeasures for defense, but in generating knowledge which will benefit mankind in its daily pursuits.

Man can take great pride in his ingenuity and in the vast amount of knowledge he has accumulated. But when his considerable hill of knowledge is placed beside the vast mountains of the unknown, his stockpile is pitiable and pathetically small. As man strives for greater knowledge, he does so with the hope that some day he may learn to control himself and to apply what he has learned to his life rather than to his destruction. The Navy's basic research program, therefore, does much more than create the New Navy. It preserves our scientific strength to keep the peace; it is a very great insurance against war; it is a prudent investment in a strong and progressive economy; and most important of all, basic research promises to alleviate and eventually remove the causes of war itself.

Research Ship Cruises South Atlantic

If the ocean is to be used as a disposal for atomic wastes, we shall have to know soon where and how such material can safely be dumped. An important consideration in deciding this question is the rate at which the ocean is "turning over." In other words, how long does it take for the surface water to sink to the bottom? Estimates based on several methods and extensive research during the last few years differ widely from a time range of about 150 years to one of more than 1,000 years. Obviously, more reliable information is needed.

It is with the purpose of obtaining more data on the movement of ocean waters and on their physical and chemical properties, which will help solve the turn-over problem, that a group of scientists are now sailing the South Atlantic Ocean aboard the research ship CRAWFORD of the Woods Hole Oceanographic Institution. The cruise, which is being sponsored partly by the Office of Naval Research, got underway during the last week in January, when the CRAWFORD put to sea. The 125-foot ex-Coast Guard vessel will cross the Atlantic Ocean four times and cover about 18,000 miles before returning to its home port about June 1. Six scientists and 15 officers and crew members are aboard.

At the present time, fission products, deposited in the ocean by fall-out from nuclear weapons tests, are an aid to oceanographic studies. The introduced fall-out materials can be measured and, therefore, are an excellent tracer by means of which both the horizontal diffusion in the sea and the rate of mixing between water layers can be studied.

To obtain large water samples, a 55-gallon plastic water sampler will be lowered to various depths. The samples will be acidified on board the CRAWFORD, and the carbon dioxide will be driven off and collected chemically for analysis of its content of radioactive carbon 14 and stable carbons 12 and 13. Although carbon-14 dating techniques have been used previously to determine the age of sea water, this will be the first time such samples have been collected on complete transverse sections across the ocean. After the carbon dioxide has been removed, two 15-gallon polyethylene drums, with steel outer-pack, will be filled for return to Woods Hole by freighters from the CRAWFORD's ports of call. These samples will later be analyzed for many radioactive elements, such as strontium 90, antimony 125, cerium 144, promethium 147, possibly cesium 137, and the naturally occurring tritium.

Although the main objective of the cruise is to determine what changes may have taken place in the South Atlantic Ocean since the classic survey made by the German oceanographic ship METEOR during the years 1925-27, much of the data obtained will aid scientists in calculating the rate of ocean turn-over. There is a definite urgency to this program because of the increasing use of atomic energy. Unlike the familiar harbor pollution, that resulting from the dumping of atomic wastes in the ocean is irremedial. Wise disposal is therefore imperative.

EQUEX '57

Direct measurements of primary cosmic rays—the particles from outer space which have not interacted with the earth's atmosphere—were made over Guam during late January and early February by instruments carried aloft by Skyhook balloons. Altitudes reached by the seven balloons launched ranged between 100,000 and 120,000 feet. The operation, called EQUEX '57, is part of the cosmic-ray research program of the Office of Naval Research and the Atomic Energy Commission.

Guam was selected as the launching site because of its proximity to the geomagnetic equator, where the earth's magnetic field filters out of the cosmic-ray flux all but the very high-energy particles. The consequent reduction in low-energy background permits easier and more accurate interpretation of experimental results.

Information obtained from the flights should provide scientists with a better understanding of cosmic rays and may eventually have important applications in such fields as communications and electronics. Magnetic storms that disrupt communications are associated with sunspots, which affect the energy distribution and total flux of cosmic rays. By means of more precise measurements of the fluctuations in cosmic-ray activity, scientists may be enabled to predict solar storms, much as weather is predicted today. Data obtained from the flights will also be of value to astronomers and geophysicists.

Direct measurements of primary cosmic rays can only be obtained at high altitudes. As the rays do not appear frequently, good statistical accuracy requires that the instruments making the measurements be kept aloft for long periods. The Skyhook balloon is the only vehicle now able to carry the instruments to the required altitude and keep them there long enough to serve this purpose.

Colloquium on Radiation Effects on Materials

"Radiation Effects on Materials" is the title of a colloquium to be held March 27-29, 1957, by the Office of Naval Research and the Glenn L. Martin Co. in Shriver Hall at The Johns Hopkins University in Baltimore. A series of unclassified review papers intended to appeal to both the engineer and research scientist working on radiation effects and the development and application of nuclear reactors for power will be presented. The subjects of the papers are as follows:

- Defects in Solids and Current Concepts of Radiation Effects.
- Experimental Approaches to Radiation Studies—Radiation Sources and Dosimetry.
- Radiation Effects on Physical and Metallurgical Properties of Metals and Alloys.
- Influence of Radiation Upon Corrosion Behavior and Surface Properties of Metals and Alloys.
- Effects of Radiation on Electronic and Optical Properties of Inorganic Dielectric Materials.
- Effects of Radiation on Semiconductors.
- Effects of Radiation on Organic Materials: (a) Experimental techniques and Current Concepts, (b) Effects of Radiation on Properties.
- Effects of Radiation on Reactor Components: (a) Cores, Liquid Coolants, and Control Rods, (2) Moderators, Shielding, and Auxiliary Equipment.

On The Naval Research Reserve

Ninth Annual ONR Research Reserve Seminar

The Ninth Annual Research Reserve Seminar was held in Washington, D. C., 28 January through 9 February (Research Reviews, January 1957). Of the 101 Reserve officers attending, 24 were Air Force Reserve; 23, Army Reserve; 2, Marine Corps Reserve; and 52, Naval Reserve.

On the first afternoon of the seminar, Reservists heard three distinguished speakers. RADM Rawson Bennett, USN, Chief of Naval Research, discussed "Some Negative Aspects of Research"; The Honorable C. C. Furnas, Assistant Secretary of Defense (Research and Development) reviewed "The Military Research and Development Program"; and VADM T. S. Combs, USN, Deputy Chief of Naval Operations (Fleet Operations and Readiness) presented "Research Supports Fleet Operations." Twenty other officers and civilian specialists addressed the group as the seminar progressed.

During the second week of the seminar, the group was divided into five equal sections, each of which studied a particular phase of research and development. These fields of study were "Selected Naval Medical Research Problems," "Upper Atmosphere Research," "Automatic Data Processing," "Ship Hydrodynamics," and "Aeronautical Research and Engineering." The Reservists were given the opportunity to select the group in which they had the most interest, and it was possible to assign 80 percent of them to their first choice.

Research establishments toured by the groups included the David Taylor Model Basin; Naval Air Test Center at Patuxent, Md.; Naval

Officers attending the Ninth Annual Research Reserve Seminar

Research Laboratory; Naval Medical Research Institute and National Institutes of Health at Bethesda, Md.; Armed Forces Institute of Pathology at Walter Reed Army Medical Center; Joint Numerical Weather Prediction Unit at Suitland, Md.; U. S. Weather Bureau; and National Bureau of Standards. Comments and suggestions on the seminar were requested from the participants. A few representative comments follow:

- "I feel that I will be able to pass on to my fellow Reservists in the Army R&D just what is going on over the country and be able to encourage other Reservists to seriously put thought to joining the active Reserve."
- "The experience will have high and continuing value to me as a Reservist and naval scientist."
- "Suggest more time be spent at research laboratories and less time on preliminary indoctrination of Reserves."
- "It was the most valuable tour of duty I have had in many years."

Member of NRRC 6-8, Orlando, Florida Receives Award

Mr. Robert J. Bobber, a Lieutenant Commander in the Naval Reserve and a member of NRRC 6-8, Orlando, Florida, received a cash award for superior accomplishment from the Underwater Sound Reference Laboratory, Orlando, Florida. Mr. Bobber, assistant head of the Research and Development Department of the Laboratory, received the award for outstanding performance in preparing and presenting an invited technical paper titled "Measurement Standardization of Underwater Acoustic Influences" at the Fourteenth Bimonthly Symposium at the Navy Mine Defense Laboratory, Panama City, Florida.

Reserve Liaison Officer Reports For Duty

CDR. W. C. Avery, USN.

CDR Walter C. Avery, USN, reported to the Office of Naval Research on 3 February 1956 for duty as Fifth and Sixth Naval District Reserve Liaison Officer.

CDR Avery was commissioned as Ensign on 8 June 1940 from the University of Washington NROTC Unit. His first assignment on being ordered to active duty in April 1941 was as Assistant Air Defense Officer, USS MARYLAND. The MARYLAND was at Pearl Harbor when the Japanese attacked later that year. Following a course of instruction in radar materiel at Harvard and M.I.T. in 1944, he was assigned to the USS WEST VIRGINIA as Radar Materiel Officer. While on the WEST VIRGINIA he took part in the action at Surigao Strait and in the landings at Leyte Gulf, Mindoro Island, and Lingayen Gulf.

After the war CDR Avery was assigned to the USS SOUTH DAKOTA; the General Line School, Newport, Rhode Island; the USS E. G. SMALL (DD838) as Executive Officer; and to the Naval Reserve Training Center, Aberdeen, Washington, as Inspector-Instructor. In December 1951 he reported to the Military Assistance Advisory Group, the Hague, Netherlands, as Executive and Plans Officer. His duty at the Hague continued until October 1954, when he took command of the USS BEATTY (DD756) in the Atlantic Fleet. CDR Avery remained in command of the BEATTY until given his present assignment.

Brookhaven National Laboratory Receives Department Of Defense Reserve Award

A highlight of the annual staff meeting of the Brookhaven National Laboratory, Upton, Long Island, New York, held on 20 December 1956, was the presentation to the Laboratory of the Department of Defense Reserve Award issued by the Secretary of Defense, Charles E. Wilson. The award was presented to the Laboratory in recognition of its outstanding record for cooperation with Reservists and Reserve activities of the Armed Forces.

Presentation of the citation certificate and the award pennant to Dr. Leland J. Haworth, Director of the Laboratory, was made in the name of the Secretary of Defense by CAPT Theodore Blanchard, USNR, Deputy Chief of Staff for Naval Reserve, Third Naval District. CAPT

Leland J. Haworth, Director of Brookhaven National Laboratory, accepts Department of Defense Reserve Award for the Laboratory from CAPT Theodore Blanchard, representing the Secretary of Defense.

Blanchard, speaking on behalf of the Commandant, Third Naval District, before an assembly of over 700 staff members, complimented the Brookhaven Laboratory for its contribution toward maintaining a strong and active military Reserve. The laboratory encourages employee-Reservists of all branches of the Armed Forces to meet their Reserve obligations by granting them military leave, supplying facilities, and cooperating with the Office of Naval Research in sponsoring nuclear science seminars for Reserve Officers.

CAPT Blanchard was introduced to the Laboratory staff by CAPT John S. Medd, USNR, Commanding Officer of NRRC 3-9, Long Island, New York. This unit is composed of Brookhaven National Laboratory employees and meets at the Laboratory for regular drills.

Also participating in the presentation ceremony was LCDR George F. Cronin, USN, Assistant to the Commanding Officer for Research Reserve, ONR Branch Office, New York.

Key Men Of The Schools And Special Programs Department, Naval Reserve Training Command

The Schools and Special Programs Department of the Naval Reserve Training Command, Omaha, Nebraska, holds special interest for Research Reservists because it includes the Research Reserve Program. This department is now under the direction of CAPT F. T. Thompson, USN. The Captain is assisted by CDR D. Dillon, Jr., USNR, Assistant for Special Programs.

CAPT Thompson, a native of Fostoria, Ohio, is a graduate of the U.S. Naval Academy Class of 1936. During and immediately after World War II he served on battleships, destroyers, and aircraft carriers, and subsequently as Member, Naval Group China; Instructor, General Line School, Newport, Rhode Island; Executive Officer, USS MONTAGUE (AKA98); Aerological Officer on the Staffs of the First and Seventh Fleets; Commanding Officer, USS BARTON (DD702); Executive Officer, Department of Marine Engineering, U. S. Naval Academy; and Commanding Officer, USS VEGA (AF59). CAPT Thompson was awarded the

Bronze Star, with gold medal in lieu of second award, for outstanding performance of duty with the Naval Group China and on the Staff of the Commander of the Seventh Fleet in the Korean area. He was also awarded the Yun Hui decoration by the Chinese Nationalist Government.

CDR Dillon is a native of St. Louis, Missouri, and is a graduate of the New York State Merchant Marine Academy Class of 1933. He was an officer in the Merchant Marine until February 1941, when he reported for active duty. During the war he served in the Pacific area on board auxiliary-type ships, on two of which—the USS RIO GRANDE (AOG3) and the USS KINGSBURY (APA177)—he served as Commanding Officer. After working in a civilian capacity with the War Shipping Administration, CDR Dillon returned to active duty in 1948 and served as Port Director, Guam; Commanding Officer, Military Sea Transport Service, Kodiak; Director, Passenger Division, MSTS, Pacific area; Chief Staff Officer, ComServDiv31; and Operations Officer, ComServRon3.

Group Training Of Reserve Officers At White Sands Proving Ground

The 16 Reserve officers who took part in group training duty at the Naval Ordnance Missile Test Facility at White Sands, New Mexico, on 16 November 1956, want more of the same, according to LT Clyde S. Brooks, USNR, Commanding Officer of NRRC 8-4, Houston, Texas. The reason: The Commander of the U. S. Naval Ordnance Test Facility arranged an excellent schedule of demonstrations, including the firing of four test rockets—the Nike, Honest John, Corporal, and Dart.

Of the 16 Reservists participating, 6 were members of NRRC 8-4, 5 were members of the U. S. Army Reserve Research and Development Company 4001, and 5 were members of the U. S. Air Force Reserve Troop Carrier Wing 446.

Arrangements for transportation to and from White Sands were made by the Commanding Officer of the U. S. Air Force Reserve Troop Carrier Wing 446, Ellington Field, Houston, Texas.

NRRC 3-13, Port Newark, New Jersey, Activated

NRRC 3-13 has been officially activated at the Port Newark Naval Training Center, Port Newark, New Jersey. CDR R. H. W. Heartel, USNR, has been named Commanding Officer of the company, which has 19 charter members.

CDR Horace F. Burr, USNR, Special Assistant to the Chief of Naval Research (Research Reserve), officially activated the new company. Also present at the meeting were LCDR George F. Cronin, USN, Assistant to the Commanding Officer for Research Reserve, Office of Naval Research Branch Office, New York, and CAPT Howard B. Stevens, USNR, Commanding Officer of NRRC 3-1, New York.

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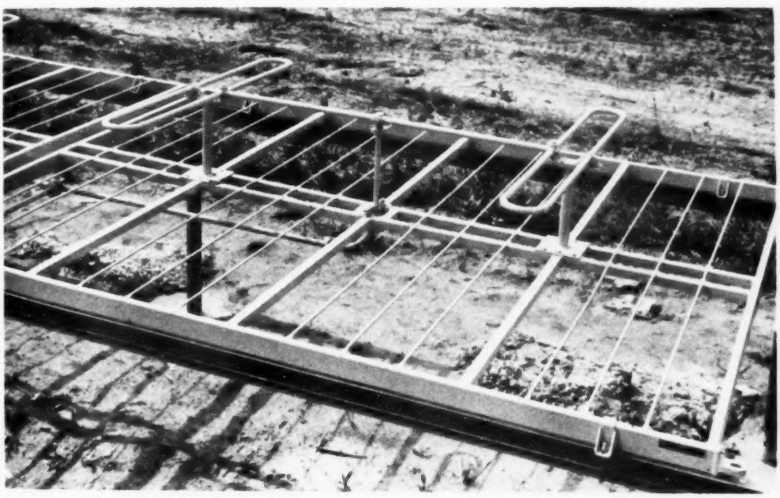
LAST MONTH WITH VANGUARD . . .

•Six gold-plated magnesium spheres—forerunners of the actual satellites—have been received by NRL. They are 20 inches in diameter and .032 inches thick. They were built by Brooks and Perkins, Inc., of Detroit under Navy contract.

The final outer coatings of the spheres are being applied at the (Army) Corps of Engineers' R and D Laboratories at Ft. Belvoir. Four coatings go on over the as-received gold plating: an "adhesive" layer of chromium, a separating layer of silicon monoxide, next a layer of highly reflecting aluminum, and a thick final layer of silicon monoxide, which is to absorb infrared rays and emit heat and thus protect the aluminum. The coating is done in vacuum vats in which the vaporized coating material is deposited on the spheres by condensation.

•When the VANGUARD satellite gets into its orbit it will be about as visible, optically, as a shiny golf ball travelling at the speed of sound at 60,000 feet. So the initial pick-up will be done by radio; by a small 10 to 50 milliwatt transmitter called the Minitrack. To detect the weak signal—only a millionth as strong as standard radio broadcast—will require something special in the way of receivers. One has been built in prototype at NRL and is already in operation. Eleven more are being built by Bendix Aviation Corp. By measuring the minute differences in time required for the signal to reach each of several ground antennas—spaced as much as 500 feet apart—the position of the 20-inch sphere whirling 200 to 1,500 miles above the earth will be pinpointed.

•A "coasting time computer" has been completed and exhaustively tested by Air Associates, Inc., under a subcontract with the Glenn L. Martin Co. The computer will determine the exact moment when the third stage of the launching vehicle will be fired, injecting the satellite into its orbit.



Part of the Minitrack antenna layout at NRL's satellite tracking station at Blossom Point, Md.

In This Issue

COVER PHOTO: "Country boats" on the Bengal Delta, East Pakistan. The delta was recently the subject of geologic studies sponsored by ONR.

RESEARCH REVIEWS endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. . . . Research Reviews is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $.15 per individual copy.

Approved by Bureau of the Budget, 28 February 1955