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RESEARCH REVIEWS

- GLACIER, HISTORIAN OF THE WEATHER
- ON THE COLOR OF MINERALS
- SCIENTIFIC MANPOWER AND MILITARY RESEARCH
- DIAGNOSTIC ADVANCES AT VIRUS LABORATORY
- THE ATMOSPHERE IN A SUBMARINE
- ON THE NAVAL RESEARCH RESERVE

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

NATIONAL MILITARY ESTABLISHMENT · UNITED STATES OF AMERICA

NAVEXOS P-510

COVER PHOTO: Looking southwestward across Seward Ice Field to Mt. Augusta (14,070 feet) near center and Mt. Elias (18,008 feet) on the right. Base of mountains are about 15 miles away.

CONTENTS

July 1949

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH

Approved by Bureau of the Budget, 13 April 1948.

RESEARCH REVIEWS

Informs the Fleet of ONR-sponsored Research

Editorial Notes

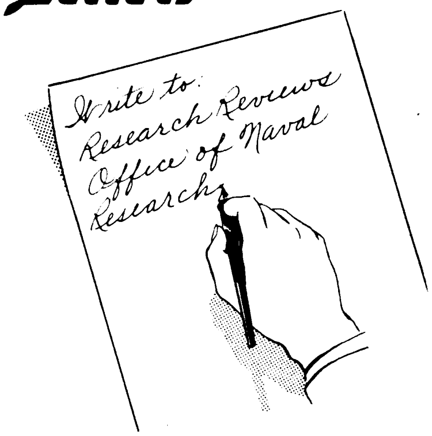
The Naval Research Reserve is a rapidly growing arm of the Navy's scientific research potential. The second annual scientific research seminar is being held the weeks of June 8-21 as this issue goes to press. The August issue of Research Reviews will carry an article on the highlights of the seminar which includes many interesting topics and speakers. For two weeks 100 officers now in Washington will review Naval facilities, learn first hand about the ONR research program, and hear top-flight scientists and administrators explain the policies and problems associated with the National Military Establishment's scientific defense effort. They will hear much about their role in this effort, why they are needed, and ways in which they can help.

Cdr. W. C. Hughes, USNR, Planning Officer for the Volunteer Reserve, Bureau of Naval Personnel, in speaking at one of the Seminar's sessions said: "The Bureau of Naval Personnel is very much in favor of the type of scientific seminar sponsored by ONR because we think it offers an opportunity, in an organized way, to provide training for a large group. It affords an excellent opportunity to disseminate information valuable to members of the Research Reserve. In addition, it also furnishes an occasion for the reserve scientist to meet with others in his field for a crossing of ideas and for a greater feeling of cohesiveness in the research program."

Since authorization for the Naval Research Reserves was approved in August 1948, approximately 2500 members have joined up, organized into sixty different units throughout the continental United States.

While Research Reviews is not issued primarily to inform the Naval Research Reserve, comments received by the editors indicate that it has been profitable and useful to number the Research Reserves among the readers of this Journal. We are glad to be able to include them in our distribution. Many of the Reservists have responded enthusiastically to the Journal and the editors hope they will write more often, giving the benefit of critical comments, whether favorable or otherwise. So bring those ideas to light and pass them along!

Letters



Dr. Robert P. Sharp, Professor of Geomorphology at California Institute of Technology, author of the first article in this issue writes to us from Yakutat, Alaska.

"I've always been interested in mountain glaciation, but the first opportunity to study live glaciers came in 1941 as a member of the Wood Yukon expedition in the St. Elias Range along the Alaskan border. During the war further acquaintance was made with Alaskan and Aleutian areas, and I was happy to return again to Alaska in 1948 as part of the Arctic Institute's "Project Snow Cornice."

"We are in the second phase of that project now, but the usual difficulties besetting such an operation are plaguing us. At the moment it's bad weather and repairs to the plane. Again let me express appreciation for the opportunity to participate in your Research Reviews."

Robert P. Sharp
Yakutat, Alaska

"I have been enjoying your publication very much and it is very flattering to receive this invitation to write for you.

"I will begin work . . . in a week or two and perhaps I can get a manuscript to you sometime in August."

V. D. Frechette
New York State College of Ceramics at Alfred University

Dr. Frechette's article should interest our readers because of the timeliness of his work, which is aimed at the current development of refractory bodies. He is studying the physical chemistry of metal-ceramic combinations. A radioactive tracer laboratory is being established to apply tracers to his work.

Dear Sir:

"This is just a note to express my appreciation for your excellent little journal, "Research Reviews." It is a very fine little journal, and expresses in interesting and readable fashion enough information to let your readers know something about various ONR projects.

". . .Also I feel that the usefulness of the Journal has been vastly extended by the adoption of the policy of putting out the Journal in an unclassified form. I learn also with pleasure of your intention to put out a volume and number system for the Journal beginning perhaps next year, and I hope also that you will carry an index for each volume."

Walter Orr Roberts
High Altitude Observatory of Harvard University and University of Colorado

The Editors thank Dr. Roberts for his comments. With regard to his suggestion of an index for each volume, the most current index available appears in the March 1949 issue of Research Reviews.

The Editors

GLACIER, HISTORIAN OF THE WEATHER

Robert P. Sharp
California Institute of Technology

The southern coast of Alaska is one of the world's most accessible areas of large glaciers. As a result, the lower parts of Alaskan coastal glaciers have been extensively observed and studied since they first became known to the modern world through the exploratory voyages of Cook, Vancouver, La Pérouse, and others in the late eighteenth century. However, the high, rugged, snow- and ice-bound mountains from which these ice streams flow are difficult of access, and information on the gathering grounds of these glaciers is correspondingly scanty.

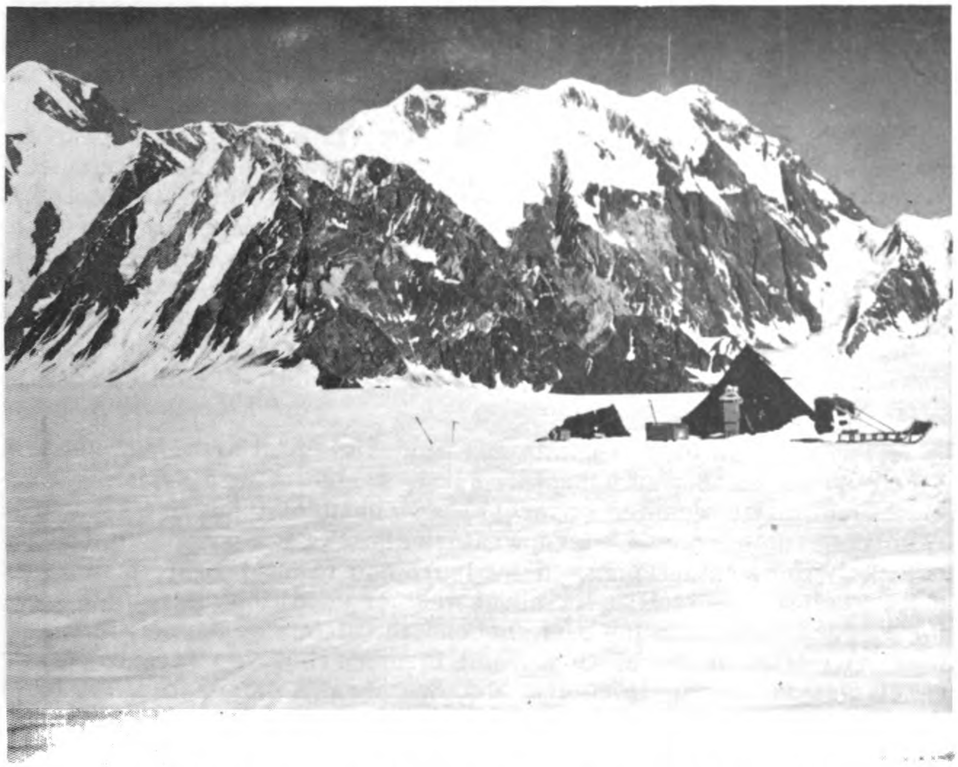


Fig. 1. Glaciological research camp near eastern edge of Sewara Ice Field looking east. Mt. Vancouver (15,700 feet) in background.

In 1948 "Project Snow Cornice" sponsored by the Arctic Institute of North America and directed by Walter A. Wood offered opportunity for investigating the nourishment areas of glaciers along the Alaska-Yukon border. A contract with the Office of Naval Research afforded the means of capitalizing on this opportunity, and a research station was established near the eastern edge of the great Seward Ice Field in the heart of the St. Elias Range. Although this station is actually in Canada

Robert P. Sharp, professor of geomorphology at the California Institute of Technology, received his B.S. and M.S. degrees (1934 and 1935) from that institution and his A.M. and Ph.D. from Harvard University. He taught at both the Universities of Illinois and Minnesota. During the war he served with the Army Air Force in their Arctic, Desert, and Tropic Information Center. He has been teaching since 1947 in the field of physical geology at the California Institute of Technology.

(60° 23′ N., 139° 53′ W.), it is most easily reached by a northward plane flight of about 60 miles from Yakutat, Alaska, and the Seward-Malaspina glacier systems lie partly in Canada and partly in Alaska. These glacier studies are still largely in the information-gathering stage, and the work of 1948 served principally to lay the ground for more extensive investigations to be made in the summer of 1949.

A major objective of most glacier studies is to determine the state of health of the ice body. This is done by determining the difference between income, chiefly in the form of snow, and expenditures, largely by melting. In 1948, at elevation 5700 feet on Seward Ice Field, the excess of accumulation over wastage for the year 1946-1947 was found to be about 35 inches of firn, a coarse granular snow of density 0.45 or greater. This can be more accurately expressed as equivalent to 17.5 to 18 inches of water. Preliminary figures indicate the excess accumulation for 1947-1948 to be about 23.5 inches of water. Seward Glacier flows 20 miles southward from this icefield through a steep canyon and spreads out on a broad flat coastal plain close to sea level to become part of the great Malaspina piedmont sheet. In this lower area wastage far exceeds accumulation, so the Seward draws on its accumulated reserve in the ice field. If this reserve is not sufficient to meet total expenditures, the glacier runs a deficit and retrenches by recession. If the accumulated reserves surpass expenditures, the glacier, like an optimistic businessman, expands. Total wastage of the Seward Glacier system has not yet been determined, so the balance sheet cannot be completed. That is one of the tasks set for 1949. Most glacier systems throughout the world are currently running a deficit, and this one will probably prove no exception.

The present state of health and immediate past history of glaciers have several significant aspects. First, a glacier is a relatively efficient, automatic weather observer, and most of them are located in relatively remote areas where weather stations are not maintained and not likely to be established. If we learn how to interrogate them properly, glaciers can tell a lot about weather conditions in remote areas for a decade or two in the past. Second, the ultimate cause of "ice ages" is still a matter of speculation. Some theories require alternate periods of glaciation in the Northern and Southern Hemispheres. If these theories are sound, it would be reasonable to expect present glaciers in these hemispheres to be approximately one-half cycle out of phase. Such does not seem to be the case, but more information is needed. The Seward Ice Field is but one reference point in an extended investigation of such matters being carried out under auspices of the American Geographical Society. It is hoped that Navy aerologists will be able to join the project in 1949 to make micrometeorological studies on the Seward Ice Field. These will be directed toward determining the relative influence of radiation, conduction, convection, and condensation on wastage.

Temperature measurements at various depths in the firn by means of thermohms and a Wheatstone bridge, loaned by the Bureau of Standards, show the Seward Ice Field to be a "temperate" glacier; that is, one which is at its pressure-melting temperature throughout, except for a thin surficial crust chilled to subfreezing temperatures in winter. Refreezing of downward percolating meltwater in the spring is thought to be largely responsible for development and growth of the horizontal ice bands and vertical pipes of coarsely crystalline ice in the firn. In mid-summer after the winter's chilled layer has been destroyed, the amount of meltwater percolating through the granular firn is surprisingly

Fig. 2. Crevasses expose the third dimension and reveal numerous horizontal ice bands in the firn.

large. This water accumulates at a depth of 65 to 70 feet to form a water table. Thermal borings first suggested this, and it was later confirmed by finding standing water in crevasses at that level. The winter's chilled layer probably does not penetrate much deeper than 50 to 60 feet, so the intriguing thought arises that a well drilled into the Seward Ice Field would probably yield water even in the dead of winter when all other sources are frozen.

In 1948, parties from the Canadian National Research Council used seismic apparatus and a sonic echo-ranging set in attempts to measure ice thickness. The seismic operation was not too successful, but one reflection obtained within 3 miles of the eastern edge of the Seward Ice Field indicated a possible 1600 feet of ice. The sonic ranging set gave promising results to a depth of about 450 feet. This would seem to be a useful method in thin ice, but its ultimate possibilities and limitations are as yet undetermined. An attempt was also made to use radar for determination of ice thickness. A reasonable transverse profile of a small valley glacier with a maximum thickness of about 700 feet was obtained by radar reflections, but the method needs checking and confirmation by some independent means. That is to be one of the major endeavors of the 1949 program. Through generous support by ONR, a modern portable seismic outfit adapted to glacier work is being procured and will be operated over the same profiles as the radar. By this procedure it is hoped to "prove out" the radar soundings and to determine the accuracy and limitations of that method of probing glaciers.

Dr. Henri Bader, formerly of the Swiss Snow and Avalanche Commission, is to join the project in 1949 and is planning a program of crystallographic and structural studies on the Malaspina Glacier west of Yakutat Bay. It is known that ice starting as tiny delicate snow flakes high in the mountains ends up as large crystals several inches in diameter at the edge of Malaspina Glacier about 60 miles south and perhaps thousands of years later. In the process of flowage, the ice crystals grow in size and develop a preferred crystallographic orientation. The problem is to determine the processes and conditions which bring about this transformation.

In brief then, the aim of this project is to learn more about snow, ice, and glaciers as part of man's continuing effort to comprehend more fully the elements of his natural environment.

Geophysics

The Navy's program in geophysics is still young. It is a new and important field of investigation. The program sponsored by the Office of Naval Research includes meteorology, oceanography, and earth sciences. In meteorology, research is being conducted on the physical processes and properties of the atmosphere; in oceanography, data are being gathered concerning the sea, ocean floors, and improved instruments for measurements; in earth sciences, the size, shape, and composition of the earth are being studied.

Under the geophysics program, ONR has participated in the scientific phases of: the Finn Ronne Expedition to Antarctica; Bikini Scientific Resurvey of 1947; Project Volcano, or air-borne magnetometer survey of the Aleutian arc and Northern Marshall Islands; Operation Highjump to Antarctica; seismic and microbarometric observations of the Helgoland demolition, or Project Big Bang; Project Cima, or the coordinated investigations of Micronesian anthropology, and the Naval medical section accompanying the University of California African expedition.

ON THE COLOR OF MINERALS

W. A. Weyl
Pennsylvania State College

When looking at a mineral, its color is usually the first thing we observe. For many minerals color is one of the characteristic properties, but it is also the one which is least understood.

The color of natural or artificial minerals, glasses, ceramic pigments and enamels is nearly always connected with the presence of an element of the transition group. Knowledge of this element alone, however, is not sufficient to understand the light absorption of the mineral. Just as important as the nature of the coloring atom is its valency, that is, its state of oxidation, and its environment. Some elements such as manganese, iron, and chromium are found in natural minerals in several states of oxidation. The orange red crocoite (lead chromate) contains hexavalent chromium and the green uvarovite owes its color to the same element in the trivalent state. A freshly mined piece of vivianite is colorless, but when exposed to air it soon turns bluish, because its divalent iron undergoes oxidation to the ferric ion. The ions surrounding the element are just as important as its state of oxidation; as a matter of fact, if one wants to draw analogies with organic dyes and speak of chromophor groups in minerals one has to include the environment of the transition element and treat the whole group of ions as the color center. In most minerals, silicates, phosphates, and carbonates, just as in glasses or aqueous solutions, the environment consists of oxygen ions and can be described by the number of oxygen ions (coordination number) and by their arrangement in space. In contrast to aqueous solutions and glasses where the environment shows considerable fluctuations, minerals, just as crystals, demand a certain symmetry in order to satisfy the crystal structure. This symmetrical arrangement of ions surrounding the element of the transition group causes the light absorption to be sharper, the color to be more brilliant. For example, rhodonite ($MnSiO_3$) when free of iron is pink or red. This mineral can be fused and obtained as a glass, but then its color is brown. The symmetry of the environment causes the light absorption of an anisotropic mineral to depend on the direction, a phenomenon which is called dichroism or pleochroism.

For studying these color problems it is frequently necessary to synthesize a mineral or to use pure inorganic compounds. Many minerals

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Woldemar A. Weyl, professor of glass technology and Head of the Department of Mineral Technology, Pennsylvania State College, State College, Pennsylvania, received his education in Germany, in the field of chemical engineering. He was formerly head of the Department of Glass Research, Kaiser Wilhelm Institut, Berlin-Dahlem, Germany. He joined the staff of the Pennsylvania State College in 1938 where he has been since that time.

Dr. Weyl is a member of the professional societies in his field and has published about eighty papers on the structure of solids, glasses, fluorescence, light absorption, and solid phase reactions.

contain more than one element of the transition group. A copper-calcium silicate known as Egyptian Blue, obtained by solid phase reaction of the proper proportions of CuO, $CaCO_3$ and SiO_2 and recrystallization with sodium chloride as a fluxing agent, is deep blue. In polarized light, however, one observes that only in one direction is the crystal deep blue. In another direction the crystal is practically colorless or faint purple. Egyptian Blue has a layer lattice and the oxygens surrounding the cupric ion are closer in one direction than in the other. The cupric ion introduced into an isotropic sodium calcium silicate, on the other hand, produces a uniform blue color which is independent of the direction.

These relations between light absorption and environment of an ion explain the color of many minerals. Light absorption is a process which involves the outer electrons, i.e., the same orbits which are also determining the chemical properties of the element. These orbits are affected by the electrical fields of the crystal, especially by the immediate environment. For many minerals and inorganic compounds the atomic structure has been determined by means of x-rays, so that the environment of the ion is known. This knowledge makes it possible to use color or fluorescence as an indicator to learn something about the atomic structure of materials which cannot be explored by x-rays or other tools.

For example, let us take the cobalt ion Co^{++} as an indicator. This ion can be introduced into a number of synthetic minerals. In periclase (MgO) it produces a pink color similar to the aqueous solution of a cobalt salt. Periclase has rocksalt structure, which means that the Co^{++} ion finds itself surrounded by six oxygen ions in a highly symmetrical fashion. If one replaces a part of the magnesium in periclase by cobalt, one obtains a pink pigment, but a blue one with the spinel $MgO.Al_2O_3$. In spinel the magnesium and, consequently, the cobalt have the coordination number four rather than six. With this information, CoO_4 groups are blue and CoO_6 groups are pink, one can now explore other crystals or glasses. Cobalt oxide introduced into a low melting glass of boric oxide with some alkali produces a pink color which turns blue on heating. As this color change is reversible, one can follow structural changes in a melt or in a glass. The author used this method to prove that a rapidly cooled glass has a different atomic configuration than one which has been cooled slowly. Knowledge of the light absorption of certain ions in different crystal structures provides a powerful tool for studying structural problems under conditions where other methods fail.

Some minerals which are colorless play the role of a host for a colored compound. Hydrated aluminum phosphate (wavellite) is white when free of impurities. The bluish turquoise owes its color to $Cu(OH)^+$ groups replacing some of the $Al(OH)_2{}^+$ groups. The sodium calcium hydrosilicates are colorless, but the schizolite is pink. It contains some MnO replacing a part of the CaO.

This simple picture of a mineral acting as a "solvent" or "diluent" for a colored compound applies only to carbonates, phosphates, hydrosilicates, and arsenates which have anions of relatively low polarizabilities. For sulfides and for some oxides this is no longer true. Cr_2O_3 "dissolves" in spinels with its green color (uvarovite), but in corundum with red color (ruby). For explaining these colors the forces acting between cations and anions have to be considered. Replacing the noble-gas-like Al^{+++} ion by Ga^{+++} having 18 outer electrons produces the normal green color of chromium.

An examination of the forces acting between large and polarizable anions and cations of different electron configurations not only explained some unusual colors of minerals but, in addition, it revealed a principle which causes the separation of sulfidic ores from silicate magmas. The fact that no natural mineral is known, which has a blue color due to cobalt oxide, led to the following theory. The original magma contained cations and anions in haphazard distribution. On cooling, the cations, with incomplete outer electronic shells, such as cobalt, coordinate themselves with the most polarizable anions, S^{--}, Se^{--}, P^{---}, As^{---}, etc. As a result, no primary minerals containing Co^{++} in fourfold coordination with oxygen are formed. The typical cobalt blue obtainable in synthetic minerals and in glasses is caused by CoO_4 groups, the stable high temperature coordination of cobalt. All cobalt minerals containing Co^{++} surrounded by O^{--} ions (phosphates, hydrosilicates, arsenates) have formed from the sulfide, arsenide, phosphides at low temperature. As a result, they contain the low temperature coordination CoO_6 which produces pink to red hues.

This work is sponsored by the Geophysics Branch of the Office of Naval Research.

Wood

The Office of Naval Research sponsored a symposium on "Wood" June 16 and 17 at the National Academy of Sciences. Participating were scientists from the National Military Establishment and other governmental agencies, universities and industry. Several hundred other scientists concerned with the field of wood supply and utilization, ranging from forestry to engineering took part in the discussion.

Wood, one of the most important and critical materials used in modern military operations, is second only to steel in quantity used by the National Military Establishment. Although capital ships are no longer constructed of wood, the Department of the Navy used a quarter of a million board feet of high quality lumber during the year 1948. The engineering and supply problems of wood were of major concern to all services during World War II.

The Office of Naval Research is administering a program of research to find more and better supplies of wood for Naval applications. Searches for new sources of high-grade lumber are being conducted in the Tropics and elsewhere. Other studies of wood under the Office of Naval Research sponsorship include engineering problems of wood usage and the diseases and parasites of wood.

Various phases of wood research are being carried out under Navy contracts with the following organizations: Yale University, New Haven, Connecticut; University of Chattanooga, Chattanooga, Tennessee; Syracuse University, Syracuse, New York; Forest Products Laboratory, Madison, Wisconsin; and William S. Clapp Laboratory, Duxbury, Massachusetts.

The entire proceedings will be published by the Office of Naval Research and made available to those interested.

The symposium on wood is one of a series of scientific conferences being sponsored by the Office of Naval Research.

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SCIENTIFIC MANPOWER AND MILITARY RESEARCH

John Harms
American Council on Education

The effectiveness with which military scientific research and development is being carried forward is of deep concern to the Department of the Navy. The physical facilities of the laboratories operated by the military services are equal or superior to those of industrial and independent research organizations; but though there is justifiable pride in the achievements of the eminent civilian scientists and engineers employed in these laboratories, yet great improvement is needed in the solution of problems related to scientific manpower. Failure to solve these problems constitutes a weak link in military scientific research.

There has been a growing concern that the Armed Services too frequently lose many of their most able and promising scientists and engineers due to negligence (1) in failing to insure working conditions conducive to good research, and (2) provide opportunities for professional development.

The Department of the Navy has not been unmindful of the situation. As early as 1944 two of the large Naval research activities, the Naval Research Laboratory and the Naval Ordnance Laboratory, initiated graduate study programs for their professional personnel, in which, by arrangement with nearby universities, regular courses, accredited for advanced degrees, were offered during late afternoon and evening hours at these laboratories. Other laboratories and bureaus have since organized similar programs. Considerable progress has also been made by some of the naval laboratories whereby many of the leading universities will accredit the research work of their graduate students, employed at the laboratories, toward an advanced degree.

In the area of recruitment equally significant advances have been made. For example, special boards of examiners have been established at strategic locations to facilitate meeting the Navy's needs. These boards have arranged for recruiting trips by experienced scientists and

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John Harms, research associate, American Council on Education, is presently engaged in research under the ONR-sponsored contract with that institution. He received his B. A. degree in 1926 from the University of Iowa in the field of psychology and science, his M. A. degree from the University of Pittsburgh in 1941 in physics and education.

He was formerly director of teacher training at Iowa State College from 1935-1943. He was later employed by Iowa's Education Department to conduct science teaching demonstrations. During the war he was lieutenant in the Navy, instructing in meteorology, climatology, and aeronautical engineering. During 1946-47 he was Science Education Advisor with the Office of Naval Research to develop plans for graduate training programs for Naval scientists and engineers in the Washington area.

He is co-author with A. H. Hausrath of a high school text book, Consumer Science.

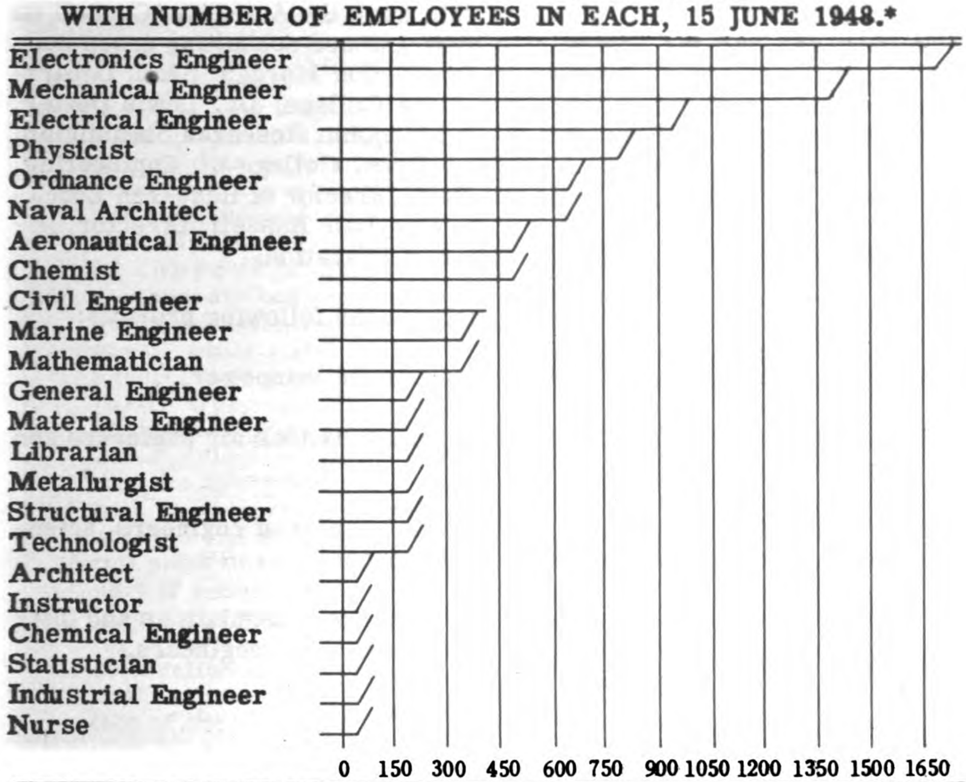
personnel officers, to inform senior and graduate students at leading universities about the Navy's employment opportunities. In the area of examinations for federal employment the boards have made considerable progress in closing some of the time gap between application for a federal position and final notification to report for work.

Significant as these much needed changes have been they have nevertheless affected and aided far too small a number of naval installations. Furthermore many other problems still need solution. Therefore, the Office of Naval Research contracted with the American Council on Education to study Navy's needs and determine means for attracting and retaining well qualified scientific and research personnel, and for insuring their effective utilization and their professional development.

The contract staff of the American Council on Education has conducted a preliminary study to determine the number, type, grade, and distribution of Navy's professional personnel, and is now engaged in conducting research into two major phases of the problem, (1) professional training needs, and (2) scientific manpower resources.

The magnitude and complexity of the task are indicated by the fact that more than 12,000 professional persons are employed at 268 naval installations of widely varying size and type, and that the positions range in grade from P-1 to P-9, in more than 120 different categories, from Tool Engineers to Research Administrators.

PROFESSIONAL CLASSIFICATIONS OF POSITIONS IN THE DEPARTMENT OF THE NAVY WITH NUMBER OF EMPLOYEES IN EACH, 15 JUNE 1948.*



*While more than 128 different classifications of professional positions exist in the Department of the Navy, this chart shows only those categories in which more than 100 persons are employed.

The first phase of appraising professional training needs embraces the following projects:

I. Determination of science education needs at Naval installations.

II. Survey of past experiences, present practices, and current thinking in respect to the professional development of scientific personnel.

III. Patterns of cooperation between institutions of higher learning and government and industrial laboratories to meet the training needs of professional employees.

IV. Suggestions for a Navy-wide program for the professional growth of scientists.

V. What should be taught to encourage creative thinking.

VI. A pilot program for science education.

VII. Evaluation of the pilot program.

VIII. Techniques for making the program of professional development known to scientists and engineers employed by Navy.

In planning the first phase of this work the American Council on Education has had the advice of a distinguished consulting group consisting of the following members: Dr. Barton Morgan, Head, Department of Vocational Education, Iowa State College; Dr. Lewis Dexter, Sociologist, Hobart College; Dr. E. F. Lindquist, Research Statistician, University of Iowa; Dr. R. A. Seaton, Dean, College of Engineering, University of Kansas; Dr. J. R. Van Pelt, Director of Research Education, Battelle Memorial Institute; Dr. John Dale Russell, Director, Division of Higher Education, U. S. Office of Education.

The second phase of the work includes the following projects:

I. Effects of Selective Service on scientific manpower.

II. Analysis of requirements of Naval installations for engineers and scientists.

III. Analysis of the present and potential supply of engineers, scientists, and technical supporting personnel.

IV. Evaluation of Civil Service Procedures and Regulations and their effect upon the procurement of scientists and engineers.

V. Sources of supply of engineers and scientists.

VI. Pilot recruitment program.

VII. Interchange of personnel with universities and industries.

VIII. Factors conducive to effective work by Navy scientific personnel.

IX. Special programs to increase the supply of trained research workers.

X. Untapped sources of manpower.

This second phase has been developed with the assistance of another consulting group made up of: Dr. R. H. Fitzgerald, Chancellor, University of Pittsburgh; Dr. H. L. Dodge, (Physicist) President, Norwich University; Dr. H. P. Hammond, Dean of Engineering, Pennsylvania State College; Dr. A. A. Potter, Dean of Engineering, Purdue University; Dr. N. L. Drake, Professor of Chemistry, University of Maryland.

The entire research study is under the direction of Dr. Douglas E. Scates, formerly of Duke University.

The work will culminate in the preparation of a working manual for administrators, personnel directors and training officers, and will point the way toward the institution of coordination procedures aimed at solving some of the scientific manpower problems with which we are now confronted.

Scientific Manpower

"...But what of the problem of scientific manpower? If we grant the desirability or even the urgency of a national program in support of research of the magnitude recommended, have we actually an adequate number of scientists and engineers for the job we need to do? It is commonly said that we have not, and that no considerable expansion in support of research can be started at once without serious dislocation of existing programs. The demand for qualified scientists by industry and by Government is very great, while universities and colleges are understaffed to handle their high enrollments. But this statement is only partly true, and like all part-truths, can prove a serious obstacle to proper action. It is true that the need for competent scientists in industry and in Government is great and that the available supply is low, and the same can be said with even more force with respect to the teaching of science at the more elementary levels. But - and this is the essential point to realize - there is still abundant room for support of research in colleges and universities, and this may take place with little if any detriment to existing programs for combined research and development. Furthermore, by application of increased support along this avenue we should at the same time take the most direct step toward alleviation of the shortage of highly trained scientific manpower. ..." *Dr. Alan T. Waterman, Deputy and Chief Scientist, ONR.*

DIAGNOSTIC ADVANCES AT VIRUS LABORATORY

M. Michael Sigel
Associate in Virology in Pediatrics, University of Pennsylvania

Several of the viral and rickettsial diseases of man can now be diagnosed with the aid of laboratory procedures. The procedures are of the same three categories used in laboratory diagnosis of diseases caused by bacteria, fungi, and protozoa, i.e., microscopic demonstration of the agent, isolation and identification of the agent, and demonstration of specific antibodies resulting from infection by the agent.

Fig. 3. Intracerebral inoculation of mouse for isolation of virus of lymphocytic choriomeningitis.

M. Michael Sigel, Associate in Virology in Pediatrics, University of Pennsylvania School of Medicine, received his B.A. from the University of Texas in 1941 and his Ph.D. from Ohio State University in 1944. During the war, from 1943 to 1946, he was a virologist in the U. S. Army and organized the Virus Section of a Service Command Laboratory in the Middle West. Dr. Sigel became the head of this section doing diagnostic work on virus diseases as well as research and epidemiologic work on influenza. From September, 1946 to October, 1948, he was in charge of the ONR-sponsored Virus Diagnostic Research Laboratory at The Children's Hospital of Philadelphia. His position as Associate in Virology with the University of Pennsylvania has been continuing since 1946, and currently he is also working on an ONR contract in research at the Virus Diagnostic Research Laboratory.

The application of the microscope to the diagnosis of viral infections is limited to those diseases in which the agent is of sufficient size to be seen with the microscope, e.g., the virus of inclusion blenorrhea. In addition, this procedure is used in proving existence of a virus in a tissue through the presence of typical inclusion bodies in cells. These represent either colonies of viruses (small pox) or changes in the cells caused by viruses (rabies). Infections of the skin by the viruses of small pox, chicken pox, herpes simplex and herpes zoster may be diagnosed by observing the virus particles in vesicular fluid with the aid of the electron microscope.

Isolating the Virus

The more commonly employed procedures are isolation and identification of the virus or rickettsia and the serologic tests. For successful isolation, the following requirements must be satisfied:

1. Material must be secured early in the acute phase of illness, from the part of the body most likely to harbor virus;

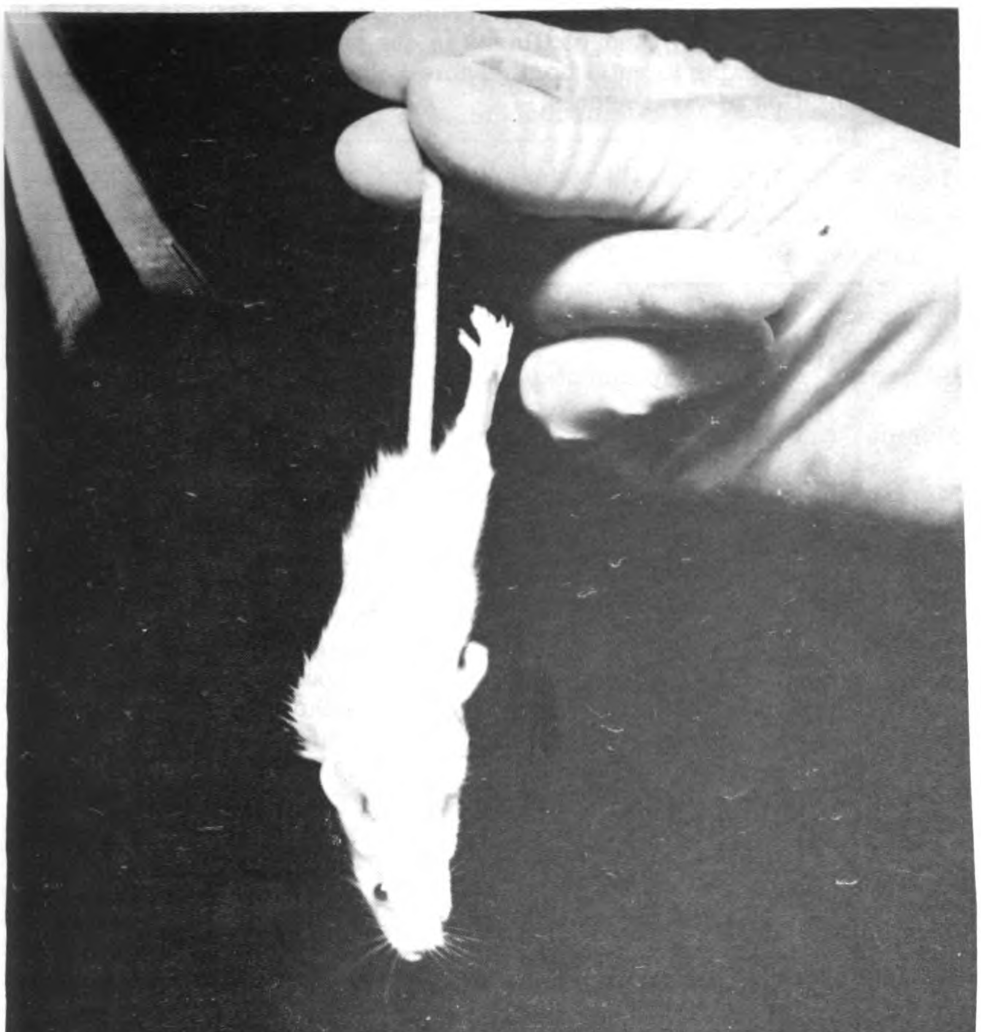


Fig. 4. Mouse in convulsion, with hind legs becoming rigid, as a result of infection with lymphocytic choriomeningitis virus.

2. Such material must be maintained in a manner most likely to preserve the viability of the agent. Usually such procedure consists of freezing the body fluid or tissue suspected of containing virus;

3. Selection of a susceptible experimental host;

4. Inoculation of this host by a route most likely to cause infection of the host. The route of inoculation depends on the type of histotropism of the virus or rickettsia;

5. Recognition of infection in the experimental host. This may be a simple matter if, after an appropriate time interval, the host shows symptoms or pathologic changes characteristic of infection by a virus in question.

Sometimes the host does not appear sick, and presence of virus must be determined by some indirect method such as the agglutination of red cells by mumps and influenza viruses. Once a virus has been isolated in an experimental animal, its identity can be established by means of serologic tests. These include neutralization and complement-fixation tests with sera specific for the virus or viruses capable of causing the particular kind of illness in the patient, and the particular reaction in the experimental host. Table I shows the procedures used for the isolation of viral agents.

Table I. Tests for indirect evidence of infection

Disease	Test	Antigen
Influenza	Hemagglutination-inhibition	Influenza virus, types A and B
Influenza	Complement-fixation	Influenza virus, types A and B
Mumps	Complement-fixation	Mumps virus and soluble antigens
Meningo-encephalitis	Complement-fixation	Lymphocytic choriomeningitis, mumps, Eastern equine encephalomyelitis, Western equine encephalomyelitis, St. Louis encephalitis
Meningo-encephalitis	Neutralization	Lymphocytic choriomeningitis, herpes
Pneumonia	Cold agglutination	Type "O" cells
Pneumonia	Complement-fixation	"Lygranum-Squibb,"* Q fever rickettsiae
Herpetiform eruption	Neutralization	Herpes simplex, vaccinia
Spotted fevers	Complement-fixation	Rocky Mountain spotted fever-rickettsial pox
Typhus	Complement-fixation	Epidemic typhus rickettsiae Murine typhus rickettsiae

*Test for antibodies to viruses of the psittacosis-lymphogranuloma group.

The advantages of this category of diagnostic procedures are:

(a) The definiteness of diagnosis when an agent suspected of causing an illness is actually isolated and identified;

(b) The recognition of new agents of disease.

Among the disadvantages of these procedures are:

(a) The difficulty in securing specimens at the proper time and in the maintenance and transportation of such specimens;

(b) Expense of the animals;

(c) The cumbersomeness of the procedures;

(d) Activation of latent viruses in animals.

Table II. Tests for direct evidence of infection.*

Disease	Experimental Animal	Optimal Route of Inoculation	Criterion of Infection
Influenza	Chick embryo	Intra-amniotic	Agglutination of red cells
Mumps	Chick embryo	Intra-amniotic	Agglutination of red cells
LCM**	Mouse	Intracerebral	Spastic convulsions
Herpes simplex (Cold sores)	Chick embryo	Chorio-allantoic membrane	Plaques
Herpes simplex (Cold sores)	Rabbit	Corneal scarification	Keratoconjunctivitis
Vaccinia (Cowpox)	Chick embryo	Chorio-allantoic membrane	Plaques
Vaccinia (Cowpox)	Rabbit	Corneal scarification	Keratoconjunctivitis

*Isolated viruses are identified by means of neutralization and complement fixation tests with known positive sera.
**Lymphocytic choriomeningitis.

Procedure in Diagnosis

The indirect, or serologic, methods of diagnosis consist of complement-fixation, neutralization, and red cell agglutination inhibition tests. The application of these tests is shown in Table II. These tests usually require two serum specimens, one taken at the time of onset, and the other about 10 to 20 days later. For certain neutralization tests, serum is required 1 to 2 months after onset.

The advantages of this category of procedures are:

1. The ease of securing, maintaining and transporting serum specimens;

2. The ease of performing the serologic tests, especially the complement-fixation tests.

The disadvantages are:

1. The limitation of these methods to those diseases, the agents of which have been adapted to growth in laboratory animals, and from which satisfactory antigens have been prepared;

2. The time interval before an answer may be obtained.

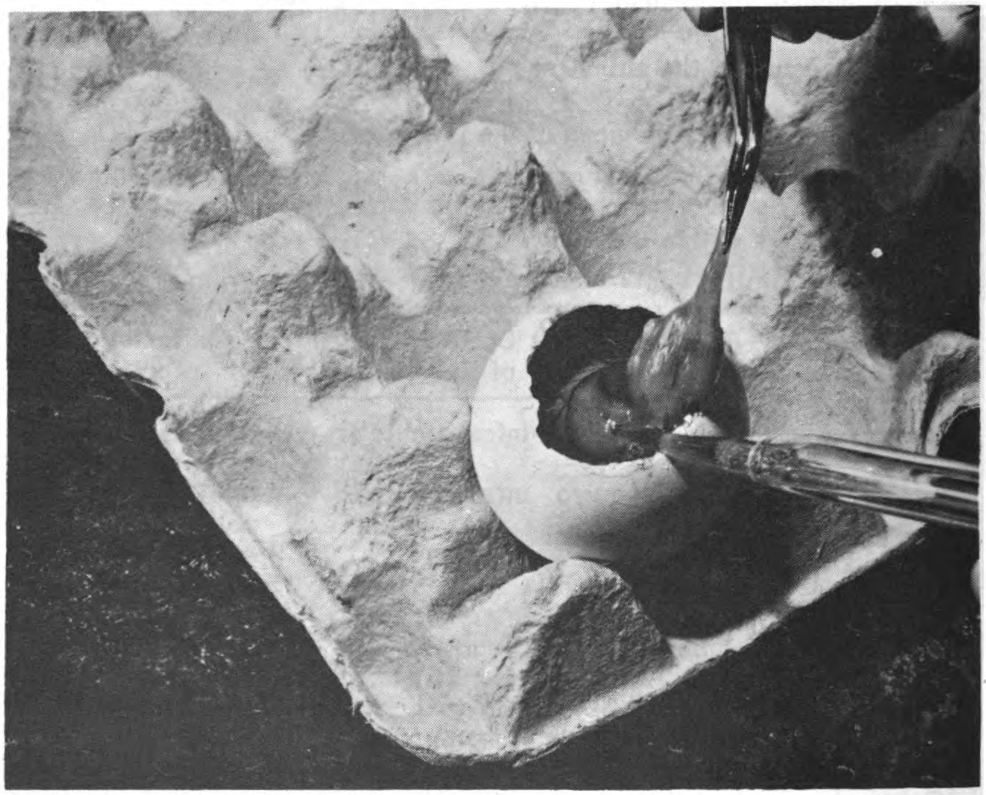


Fig. 5. Harvest of amniotic fluid from embryos infected with influenza virus.

Parenthetically, it may be said, however, that the time required to get a positive serologic result following a viral disease is not longer than that required for a positive result by similar techniques in bacterial diseases, e.g., typhoid fever. The complement-fixation test for infections with the mumps virus deserves special attention. Through the use of the soluble and viral antigens as developed by the Drs. G. and W. Henle, it is possible to make a diagnosis during the first few days of illness. This is particularly valuable, since mumps infection may give rise to such things as encephalitis as well as the swollen parotid glands with which the disease is commonly associated.

Scope of Virus Diagnostic Work

During a period of two years, the Virus Diagnostic Research Laboratory has aided in the diagnosis of influenza, mumps, mumps meningo-encephalitis, atypical pneumonia, lymphogranuloma venereum, lymphocytic choriomeningitis, Rocky Mountain spotted fever, and typhus. Table III shows the number of positive results for each of these diseases in individual patients.

Table III. Results of serologic tests on individual cases, October 24, 1946-October 24, 1948

		Positive 56		Negative 221			
	Cases	Lymphocytic choriomeningitis	Mumps	Polio-myelitis	Other Etiology*	Etiology Unknown**	Incomplete
Neurologic	329	9	47	58	33	130	52

	Cases	Positive Influenza A	Doubtful Influenza A	Negative	Incomplete
Upper Respiratory	37	3	4	20	10

		Positive 44				Negative 70		
	Cases	Cold Agglutinin	Lygranum+	Q Fever	Influ-enza***	Other Etiology*	Etiology Unknown**	Incomplete
Pneumonia	130	35	5	3	2	8	62	15

	Cases	Positive Mumps	Negative	Incomplete
Parotitis (Mumps)	37	15	7	15

	Cases	Positive	Negative	Incomplete
Rocky Mountain Spotted Fever	13	5	7	1
Typhus	2	1	1	
Lymphogranuloma venereum	7	4	3	

*Includes only those cases whose final diagnosis was reported to this laboratory.

**Final diagnosis either unknown or not reported to this laboratory.

***Not done on all specimens.

+Antigen prepared from a virus belonging to the psittacosis-lymphogranuloma group, obtained from E. R. Squibb & Sons.

Virus diagnostic procedures have thus been found to be of value to the physician and patient, and of special importance in the maintenance of health in a community.

In addition to aiding the physician in the diagnosis of cases of viral and rickettsial diseases, the Virus Diagnostic Research Laboratory has established the cause of several epidemics. During outbreaks of poliomyelitis, it was shown that some patients suspected of having atypical or abortive poliomyelitis had mumps meningo-encephalitis. Through the use of the mumps complement-fixation antigens, it was possible in patients with varying manifestations of infection to make a diagnosis of mumps with a virus, such as meningitis, orchitis, as well as the more common involvement of salivary glands. Such diagnosis was often made very early in the outbreaks, frequently during the first few days of

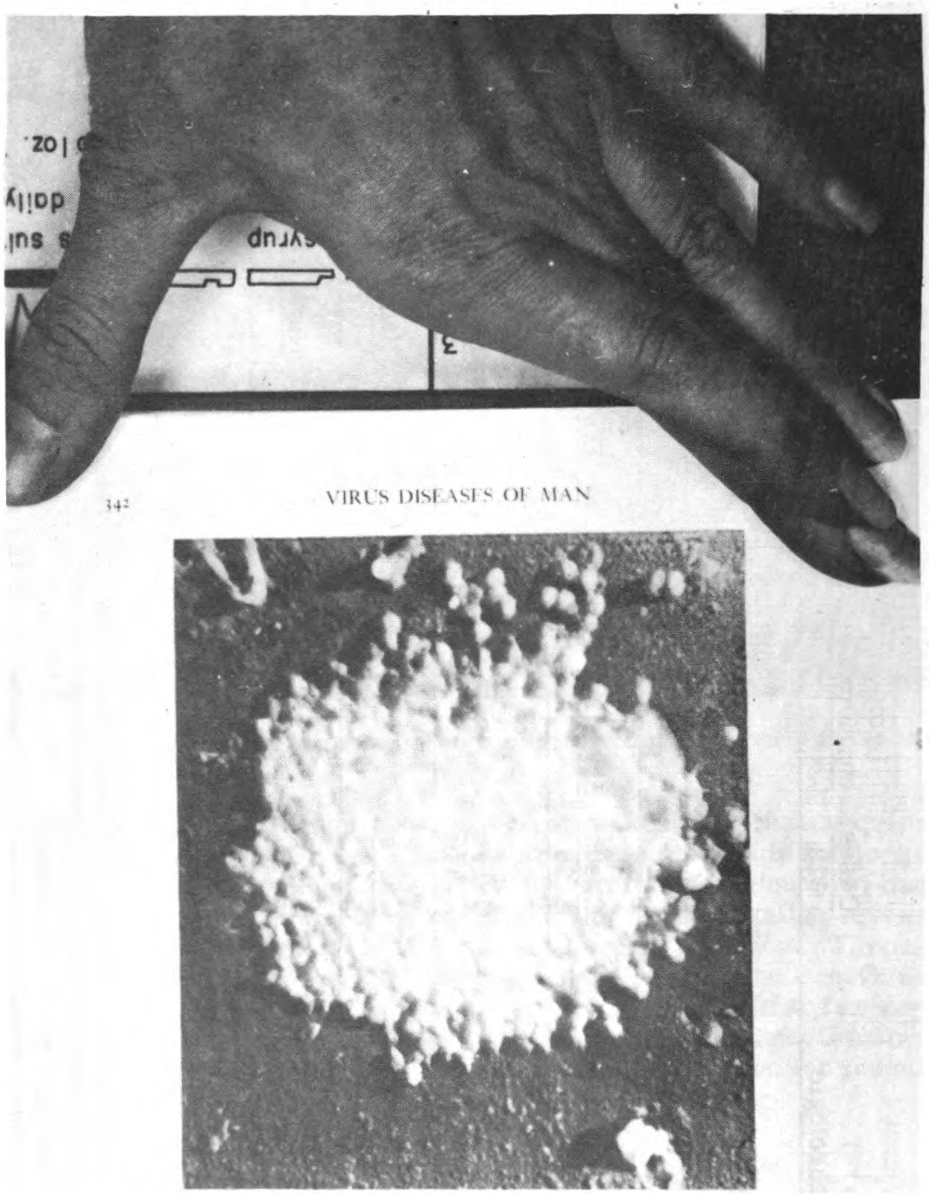


Fig. 6. Electron microscope photograph showing Guarnieri inclusion body. (From van Rooyen, C. E., and Rhodes, A. J., Virus Diseases of Man, Thomas Nelson & Sons, 1948.

illness of a patient. An outbreak of upper respiratory illness in a school for boys was diagnosed as influenza A. The salient point of this study was that the students had been vaccinated against influenza three months before the outbreak. The reason for the failure of the vaccine to protect these individuals was the antigenic dissimilarity between the viruses causing this outbreak and the viruses in the vaccine. Five strains of virus were isolated from this outbreak, and these strains were found to possess different antigenic and biologic characteristics.

Another significant result in this study was the finding that for the diagnosis of influenza, the complement-fixation test is a more sensitive procedure than the agglutination inhibition test with standard virus strains.

The finding of one case of Q fever* through the routine serologic tests for respiratory diseases has led to the recognition of an outbreak of Q fever among workers in a plant processing wool. The disease was considered to be grippe or influenza. Complement-fixation tests revealed that the outbreak was caused by the agent of Q fever (Coxiella burneti). This study has established that Q fever may be contracted in the process of handling raw wool. Thus, to the industries confronted with the hazard of Q fever (dairies, live stock) must be added the wool industry.

*Q fever was first noted in 1935 in meat workers in Queensland, Australia. It is a mild typhus-like disease caused by Rickettsia burneti.

Check Enlargement

A reliable test for the early detection of acromegaly the disease in which there has been progressive enlargement of the head, feet, and hands, has been reported by the University of California Medical School and a second test is being perfected which involves the first assay of the growth of hormones in human blood. The disease can be controlled with sex hormones if discovered in the early stages. Sudden growth after maturity is usually caused by a tumor of the pituitary gland which results in an overproduction of the growth hormone. Sex hormones, which are the balancing factors in growth, cannot suppress the over-production, and hence enlargement occurs. Scientists have successfully halted the progress of the disease by administering male and female hormones to patients. They have found that when acromegaly is present, there is a large amount of phosphorus in the blood and a test for phosphorus will indicate presence of the disease and how effective treatment is. The second test, still in the experimental stage, is to test for the growth hormones in the blood. It has been noted that there is an increase under the same conditions. This research, sponsored by ONR, was reported by Drs. Laurence W. Kinsell, George D. Michaels, C. H. Li, and William E. Larsen, Lt. (jg) MC, USN.

THE ATMOSPHERE IN A SUBMARINE

Nathan Kaplan
Kollsman Instrument Division of Square D Company

The Use of Instruments in a Submarine

The composition of the atmosphere in a submarine is an important factor in the welfare and safety of personnel. In order to maintain high operating efficiency, and to reduce hazards to a minimum, it is necessary to maintain within proper limits the concentrations of oxygen, carbon dioxide, carbon monoxide, water vapor and total combustibles. It is evident that the need exists for an instrument to keep constant watch on the composition of the atmosphere, and to signal the necessity of restorative measures. A continuous record of the contents of a submarine's atmosphere may reveal abnormal occurrences, for which corrective measures might be instituted long before their effects become dangerous.

The conditions existing in submarines impose severe restrictions on any instrument used in a submarine. Limited space requires that the equipment be small. Ruggedness is essential because of the vibrations and accelerations associated with normal and with emergency operation. Lack of space precludes assignment of additional personnel; hence, new equipment must require a minimum of attention for operation and maintenance.

Determining the Oxygen in the Atmosphere

With these requirements in mind, V. E. Carbonara, of the Kollsman Instrument Division, suggested a method of gas analysis which he had investigated briefly about twelve years ago in connection with a device to regulate the partial pressure of oxygen in aircraft cabins. This method is based on the use of sensitized tapes, impregnated with chemical reagents, which undergo colorimetric chemical reaction when exposed to the atmosphere. The extent of the color change, determined by phototube evaluation of the tape, indicates the concentration of the particular constituent being studied. This method of gas analysis is currently being investigated by the Kollsman Instrument Division, under contract with the Office of Naval Research. The ultimate plan is to develop a continuous, automatic analyzer and recorder of the constituents of the atmosphere. The immediate problem, however, is to determine the feasibility of this method of gas analysis.

The present investigation is concerned with the application of this method to the determination of oxygen. As a direct outgrowth of the earlier work by Carbonara, the oxygen-sensitive reagents examined in this study were several photographic developers of the substituted phenol

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Nathan Kaplan, research chemist at the Kollsman Instrument Division since 1946, received his B. S. and Ph. D. degrees from New York University in 1933 and 1936, respectively. During the war, he was chief of the chemistry section at the Jet Propulsion Laboratory, California Institute of Technology, where he was engaged in research on solid and liquid rocket propellants. At the present time, he is working on the ONR project described in this article.

type, such as amidol, pyrogallol, and hydroquinone. Alkaline solutions of these materials rapidly absorb oxygen and darken considerably. The tapes used as the vehicle for the reagent were uninked cotton typewriter ribbons prepared by passing them through a water solution of the oxygen-sensitive reagent, and then drying them completely, the entire process carried out in an atmosphere of nitrogen to prevent premature darkening of the reagent. The tapes are stored, until used, in a dry nitrogen atmosphere, in which they are stable for relatively long periods of time.

For testing the characteristics of these tapes, an apparatus has been built with a phototube-viewing system so arranged that light from a source falls on the tape, and is reflected in part to the sensitive surface of an RCA No. 5581 phototube. Another similar phototube, arranged in a balanced circuit, receives constant illumination directly from the light source. The oxygen concentration of the surrounding atmosphere determines the rate of darkening of the sensitized tape, and hence the response of the phototube system.

Since the reaction of these oxygen-sensitive substances occurs in water solution, it is necessary to moisten the sensitized tape at the time of use. The alkaline *p*H necessary for rapid reaction is attained by moistening with a liquid containing dissolved alkali. For this purpose, water solutions of sodium carbonate and of various amines have been used. The moistening of the sensitized tape must be uniform in order to insure correct indication of the oxygen content; furthermore, the moistening device must not come into repeated contact with the sensitized tape, because this would tend to contaminate the moistening solution with reagent dissolved from the tape. One satisfactory method is the drop-wise addition of liquid from a dropping capillary, each drop activating a small separate area of tape.

Results of this investigation indicate that this is a feasible method for gas analysis, giving the concentration of oxygen within $\pm$ 0.3% over the range 16 to 21%. Current studies are being directed toward a determination of the extent to which variables such as temperature, humidity, and flow rate must be controlled to insure reliable operation.

Determining Other Elements in the Atmosphere

Although most of the work on this project has been concerned with oxygen determination, some study has been made of a similar method of determining carbon monoxide, carbon dioxide, and water vapor. The colorimetric reagent used in the carbon monoxide studies was developed by Dr. Julius Sendroy, Jr., of the Naval Medical Research Institute. This material reacts with carbon monoxide in an essentially dry condition, utilizing the water vapor present in the atmosphere. For carbon dioxide, some consideration was given to tapes impregnated with an acid-base indicator (dilute alkaline solution of bromthymol blue). For water vapor determination, tapes impregnated with a hygroscopic electrolyte were utilized. In these tapes, which are a modification of the electric hygrometer for radiosondes, the change in electrical resistance of the tape indicated the relative humidity of the atmosphere.

ON THE NAVAL RESEARCH RESERVE

Employment of intermittent and part-time Naval Reserve technicists and scientists. (BuPers Manual Art. H-1706.)

The Chief of Naval Operations has issued the following directive regarding the intermittent or part-time employment of Naval Reserve technicians and scientists for the Fiscal Year 1951:

"(1) Appropriations made to the various bureaus and offices of the Navy Department for part-time or intermittent employment of scientists, technicists, and other personnel in connection with the work of such bureaus and offices shall be available for the active duty pay and allowances of such members of the Naval Reserve as in the discretion of the Secretary of the Navy may be placed on temporary active duty for the purpose of prosecuting such work.

"(2) Orders to officers for the performance of the above duty will be issued by the Bureau of Naval Personnel upon the request of the bureau concerned. Such orders will be issued subject to consent of the Reserve officer to whom issued and will indicate the place at which the duty is to be performed, the dates between which to be performed, the appropriation to be charged, the rate of pay involved, and mileage, if any, allowed."

Volunteer Reserve Unit 1-3

The first Naval Research Reserve unit in Western Massachusetts was officially activated at the University of Massachusetts, Amherst, Mass., May 31, 1949. (Left to right) LCDR William L. Eck, USNR, the Commandant's Local Representative; CDR Robert S. Woodbury, USNR, the ONR Director Research Reserve Program, Washington, D. C.; LCDR Edward D. Emerson, USNR, the CO of VRU 1-3 and Major A. H. Mathieson, Jr., USMCR, associate member.

TO INACTIVE PERSONNEL:

Inactive personnel, retired or reserve, regardless of rank, are not entitled to classified information merely by virtue of their present or former status. Unless they have been specifically authorized by the Secretary of the Navy or the Chief of Naval Operations to receive classified information it shall not be disclosed to them. This does not limit the disclosure of classified information to certain categories of inactive personnel who have been properly authorized access for purposes of training.

TRAINING DUTY:

The Director, Naval Research Reserve, New York Branch Office, has announced that members of Volunteer Naval Research Units having the proper qualifications and engaged in research that parallels the billet may request training duty at the

David Taylor Model Basin, Washington, D. C.
Naval Ordnance Laboratory, White Oaks, Md.
Applied Physics Laboratory, Silver Spring, Md.
Operational Development Force, Key West, Florida.
Naval Medical Research Center, Bethesda, Md.
Woods Hole Oceanographic Institution, Woods Hole, Mass.
Submarine Base, New London, Conn.
Naval Air Development Station, Johnsville, Penna.
- Pilotless Aircraft Development Laboratory
- Aviation Armament Laboratory
- Aeronautical Electronics and Electrical Laboratory

OFFICIALLY ACTIVATED VOLUNTEER RESEARCH RESERVE UNITS

Designation	Type	Meeting Place	Commanding Officer and Mail Address
1-1	Composite	Auditorium, Bldg 60 Navy Headquarters Boston, Mass.	Capt. J. W. Hammond, USNR ONR Branch Office 495 Summer St. Boston, Mass.
1-2	Composite	Brown University Providence, R.I.	Cdr. C. J. Fish, USNR Oceanographic Inst. Woods Hole, Mass.
1-3	Composite	University of Mass. Amherst, Mass.	Lt. Cdr. Edward D. Emerson, USNR Dept. of Mech. Engineering University of Massachusetts Amherst, Mass.

Designation	Type	Meeting Place	Commanding Officer and Mail Address
3-1	Composite	Cornell University Medical College New York 21, N.Y.	Cdr. J. D. Hardy, USNR 1300 York Ave. New York 21, N.Y.
3-2	Special Devices	Special Devices Center Sands Point, Port Washington, Long Island, N.Y.	Cdr. L. E. Yoder, USNR Sands Point, Port Washington, Long Island, N.Y.
3-3	Composite	U. S. Naval&Marine Corps Reserve Training Center Buffalo, N.Y.	Lt. Cdr. Ralph Bloom, Jr., USNR 184 Connecticut St. Buffalo, N.Y.
3-4	Composite	University of Rochester Rochester, N.Y.	Cdr. Henry C Sheve, USNR NROTC Unit University of Rochester Rochester, N.Y.
3-5	Composite	Yale University New Haven, Conn.	Cdr. D. S. Rowell, USNR U. S. NavResTraCen Ft. Nathan Hale Park New Haven 13, Conn.
3-6	Composite	Syracuse, N.Y.	Lt. A. O. Quinn, USNR Naval Reserve Tra Cen Syracuse (Liverpool), N.Y.
3-7	Composite	Schenectady, N.Y.	Lt. Cdr. G. H. Baldwin, Jr., USNR NavResTraCen, Scotia, N.Y.
4-1	Composite	Princeton University	Lt. Cdr. Paul Busse, USNR Princeton University Princeton, N.J.
4-2	Composite	Franklin Institute Philadelphia, Pa.	Lt. Cdr. W. G. Amey, USNR Electronics Section Franklin Institute Philadelphia, Pa.
4-3	Composite	104 Industries Hall Carnegie Institute of Technology Pittsburgh, Pa.	Cdr. N. D. Cole, USNR Office of Naval Research University of Pittsburgh 303 Thaw Hall Pittsburgh 13, Pa.
4-4	Composite	Pennsylvania State College	Cdr. E. R. Queer, USNR c/o Eng. Experiment Sta. Pennsylvania State College College Station, Pa.
W-1	Battalion	Navy Dept., Bldg T-3 Washington, D.C.	Cdr. F. C. Wiesner, USNR ONR - Bldg. T-3, Room 2714 Navy Dept., Washington, D.C.
W-1	Composite	Navy Dept. Bldg T-3 Room 1515 Washington, D.C.	Cdr. W. M. Richardson, USNR ONR - Bldg T3, Room 2602 Navy Dept., Washington, D.C.
W-3	Special Devices	Navy Dept. Bldg. T-3 Room 1803 Washington, D. C.	Lt. Cdr. A. W. Stevens, USNR Office of Naval Research Navy Dept. T-3, Rm 1815 Washington, D. C.
W-4	Enlisted	Navy Dept. Bldg. T-3 Room 1515 Washington, D. C.	Lt. Cdr. Lawrence Gardiner, USNR Atomic Energy Commission Public Health Bldg. Room 102 Washington, D. C.
5-1	Composite	University of Virginia Charlottesville, Va.	Lt. (jg) P. B. Buck, USNR 4 Copeley Hill Charlottesville, Va.
5-2	Composite	Virginia Polytechnic Institute Blacksburg, Va.	Lt. Cdr. E. D. Harrison, USNR P. O. Box 575 Blacksburg, Va.
6-1	Composite	Georgia Institute of Technology Atlanta, Ga.	Cdr. J. E. Boyd, USNR Physics Bldg. Georgia Institute of Technology Atlanta, Ga.
6-2	Composite	Alabama Polytechnic Institute Auburn, Ala.	Lt. J. E. Land, USNR Department of Chemistry Alabama Polytechnic Institute Auburn, Ala.

Designation	Type	Meeting Place	Commanding Officer and Mail Address
6-3	Composite	Oak Ridge National Lab. Oak Ridge, Tenn.	Lt. Cdr. D. J. Mallon, USNR P. O. Box P Oak Ridge, Tenn.
6-4	Composite	University of Florida Gainesville, Fla.	Lt. Cdr. E. G. Reitz, USNR College of Engineering University of Florida Gainesville, Fla.
6-5	Composite	Gulfport, Miss.	Lt. V. O. Smallwood, USNR 2412 East Ave. Gulfport, Miss.
6-6	Composite	North Carolina State Raleigh, N. C.	Lt. Cdr. R. F. Stainback Physics Department North Carolina State College Raleigh, N. C.
8-1	Composite	Tulane University New Orleans, La.	Lt. Cdr. J. M. Scott, USNR Department of Chemistry Tulane University New Orleans, La.
8-2	Composite	Louisiana State University Baton Rouge, La.	Lt. Cdr. W. K. Edwards, Jr., USNR Department of Chemistry Louisiana State University Baton Rouge, La.
8-3	Composite	Texas A & M College College Station, Texas	Lt. Cdr. Norman F. Rode, USNR Electrical Engineering Department Texas A & M College College Station, Texas
8-4	Composite	NROTC Building Rice Institute Houston, Texas	Lt. (jg) John J. Hanewicz 4811 Mt. Vernon St. Houston, Texas
8-5	Composite	University of Texas Austin, Texas	Lt. Cdr. G. H. Ayers, USNR Department of Chemistry University of Texas Austin, Texas
8-6	Composite	Galveston, Texas	Lt. (jg) C. N. Sechrist, USNR 1235 3rd Ave. North Texas City, Texas
8-	Composite	Stillwater, Okla.	Lt. O. H. Hamilton, USNR 503 Pine St. Stillwater, Okla.
8-	Composite	Bartlesville, Okla.	Lt. Cdr. E. O. Box, USNR 1642 Hickory St. Bartlesville, Okla.
9-1	Composite	Chicago, Ill.	Capt. George G. Lamb, USNR Department of Chemical Engineering Northwestern University Evanston, Ill.
9-2	Composite	University of Illinois Urbana, Ill.	Lt. Cdr. A. C. Williams, USNR Department of Psychology University of Illinois Urbana, Ill.
9-3	Composite	University of Michigan Ann Arbor, Mich.	Cdr. C. M. Davis, USNR Geography Department University of Michigan Ann Arbor, Mich.
9-4	Composite	Ohio State University Columbus, Ohio	Lt. Cdr. Karl E. Krill, USNR Engineering Experiment Station Ohio State University Columbus 3, Ohio
9-5	Composite	Iowa State College Ames, Iowa	Lt. Cdr. O. C. Kreider, USNR Mathematical Department Iowa State College Ames, Iowa
9-6	Composite	University of Minnesota Minneapolis, Minn.	Lt. Cdr. J. A. Wise, USNR 220 Experimental Eng. Bldg. University of Minnesota Minneapolis, Minn.

Designation	Type	Meeting Place	Commanding Officer and Mail Address
9-7	Composite	Purdue University Lafayette, Ind.	Lt. L. M. Baker, USNR Department of Psychology Purdue University Lafayette, Ind.
9-8	Composite	Washington University St. Louis, Mo.	Cdr. R. N. Varney, USNR Department of Physics Washington University St. Louis, Mo.
9-9	Composite	Missouri School of Mines & Metallurgy Rolla, Mo.	Cdr. R. A. Cooley, USNR Missouri School of Mines & Metallurgy Rolla, Mo.
9-10	Composite	Peoria, Ill.	Lt. Cdr. F. C. Albers 108 Devon Lane Peoria, Ill.
9-11	Composite	Cleveland, Ohio	Lt. Cdr. Viktor Schreckengost, USNR 2366 Noble Rd. Cleveland 21, Ohio
11-1	Special Devices	Los Angeles, Calif.	Lt. Cdr. H. J. Pedersen, USNR 510 W. 6th St. Los Angeles, Calif.
11-2	Composite	Pasadena, Calif.	Lt. Cdr. J. H. Biggar, USNR 680 E. Colorado Drive Pasadena, Calif.
11-3	Composite	University of California Los Angeles, Calif.	Cdr. L. P. Delsasso, USNR Physics Department University of California Los Angeles, Calif.
12-1	Composite	San Francisco, Calif.	Cdr. J. E. Laurance, USNR ONR Branch Office 601 Donahue St. San Francisco, Calif.
12-2	Biological Sciences	LeConte Physics Laboratory University of California Berkeley, Calif.	Lt. Cdr. Nello Pace, USNR Medical Physics Laboratory University of California Berkeley, Calif.
12-3	Composite	Stanford University Stanford Univ., Calif.	Cdr. L. S. Jacobsen, USNR 668 Cabrillo Ave. Stanford University, Calif.
12-4	Composite	Fresno State College Fresno, Calif.	Cdr. Ralph A. Jack, USNR 3617 Harvey Ave. Fresno 2, Calif.
12-5	Composite	University of California Berkeley, Calif.	Cdr. C. F. Garland, USNR University of California Berkeley, Calif.
13-1	Composite	University of Washington Seattle, Wash.	Cdr. H. S. Bennett, USNR 3966 Union Bay Circle Seattle 5, Wash.
13-2	Composite	Richland, Wash.	Lt. W. W. Gonder, USNR 95 Atkins Ave. Richland, Wash.
13-3	Composite	Pullman, Wash.	Lt. Cdr. W. G. Gnaedinger, USNR
13-4	Composite	Portland, Oregon	Lt. Cdr. Richard F. Stevens, USNR 355 N. Shore Road Oswego, Oregon
13-5	Composite	Corvallis, Oregon	Lt. Cdr. Albert V. Logan, USNR Corvallis Heights Corvallis, Oregon.

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