29 November 1957, Volume 126, Number 3283 SCIENCE

Science in the U.S.S.R.

Introductory Remarks

The Iron Curtain surrounding Russian progress in earth science has recently been opened in a number of ways. One rift in the "curtain" has been an increasing participation by Russian scientists in international conferences. Formerly, these representatives were closely watched by special agents. Recently, however, individual scientists have mingled freely and privately with nationals of other countries, including our own. Another important development has been a freer exchange of scientists between this country and Russia, so that experts in virtually all branches of the sciences have recently visited major facilities behind the "curtain." In return, Soviet scientists have visited here and have been relatively open in exchanging information.

Perhaps the most important development is the translations of Russian journals, which are being made on an increasingly large scale. These translations permit detailed and thoughtful evaluation of the quality of Russian scientific work. The quality of published literature is one of our best indices of the magnitude of their effort.

Inorganic Chemistry

My remarks on the quality and quantity of current chemical research in Russia are based on translations and abstracts of the chemical literature that Soviet scientists have published in the past few years. The Soviet scientists have published much good work, and it is my loss that I am not able to read the Russian language. The domain of chemistry is so broad that in order to get to specific examples and to stay within the space allotted, I shall limit my discussion, with one exception, to the field of inorganic chemistry. That exception is in the field of physical chemistry and constitutes undeniable proof that the quality of Soviet research in this fundamental field is excellent. I am referring, of course, to the award of the 1956 Nobel Prize in chemistry—the world's top award in that field of study—to Sir Cyril Hinshelwood of England and Nikolai Semenov of Russia for their brilliant and independent research on chemical kinetics, which is a study of the manner in which molecules behave in a chemical process.

Inorganic chemistry is the oldest branch of chemistry, but, until recently, it suffered from lack of interest because the newer fields of organic, physical, and biochemistry that developed during the last century and the early part of this one offered so many more opportunities for original research.

The new technologies such as nuclear power, rocket and jet propulsion, and electronics have focused new attention on inorganic chemistry, and progress on many fronts in these newer technologies is dependent on progress in inorganic chemistry. As a consequence, both in the Western world and in Russia, there has been a marked increase in the amount of research in this field. One consequence of this increase is the publication of a new journal, *The Journal of Inorganic and Nuclear Chemistry,* to which the principal contributors are British, American, and French chemists. In its three years of publication, this Western journal has averaged 800 pages of research publication per year. Last year, a Russian journal of inorganic chemistry began publication and published 2800 pages of material. During the first six months of the current year, this Russian journal has published a little over 1400 pages of research material. The Western journal is still publishing at the rate of 800 pages per year. This indicates a ratio of about three and one-half pages of Russian publication for each one in the Western publication. This ratio, of course, is not an accurate index of the relative amount of inorganic chemical research in the two areas, because there are general journals that include inorganic chemistry and because the classification of a given paper as "inorganic" may be somewhat arbitrary in some instances, but it is certainly strongly indicative of the relative amount of such research. Contrary to the situation with respect to much Russian scientific publication of ten years ago, when much of the published material consisted of review articles of results published in Western journals or repetition of work previously done, the new Russian scientific publication is rich in original work, much of it of very high quality, and it covers a wide variety of topics.

Travel at supersonic speeds requires materials that will withstand extremely high temperatures without burning and without loss of strength. Current knowledge indicates that the metals tantalum, niobium, molybdenum, and titanium, either in super alloys or in combination with certain ceramic materials, are the most likely to withstand these extreme conditions. A detailed study of the chemistry of these elements is in progress in Russia as well as in the Western world. This ranges from a study of the geochemistry of these elements (which will ultimately pay off in improved prospecting methods) to detailed studies of the reactions of these metals and of their compounds. The latter studies will ultimately pay off in improved extraction and purification procedures. The Russians, too, are well aware of the extremely great increase in strength that is characteristic of metals of extremely high purity.

The development and wide-spread use of transistors in the field of electronics is well known. The chemical elements germanium and silicon, from which transistors are made, present problems which have to do with source of raw materials for the former and methods of purification for both. The Russians have given considerable attention to the chemistry

The six articles in this group are adapted from the six addresses that were presented before the 427th meeting of the Washington Academy of Sciences on 29 October at the Cosmos Club, Washington, D.C. The general theme of the program was "Science in the U.S.S.R." The introductory remarks were prepared by Philip H. Abelson, director of the Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.

of these elements in an effort to meet these problems.

Certain of the newer compounds of boron have achieved importance in recent years because of their usefulness as jet fuels. Certain other new compounds of boron have become important as reducing agents in chemical reactions, and still others have been shown to have excellent potentialities as temperature- and abrasion-resistant materials. There is a fair amount of Russian literature concerning the two latter classes of boron compounds but little about the first class. This, I think, is due to security classification rather than to lack of interest.

The rare earth elements—a long neglected group—have achieved considerable prominence since World War II because they constitute a considerable portion of the residue from nuclear fission processes and because a number of them have interesting nuclear characteristics. The recent Russian literature shows that a considerable amount of up-to-date research on rare earth compounds is being carried out, but there is no indication that the rare earth metals are being extensively investigated.

The limitations of polymers made from organic materials have long been recognized. There is good theoretical basis for believing that some of these limitations could be overcome if controlled polymerization of inorganic materials could be achieved. Much effort in this direction has been expended, but with only a limited amount of success. Polymerized silicate ions have been obtained, of course, but they are unsatisfactory in many respects. Soviet scientists have recently reported that they have succeeded in incorporating other metals into the silicon-oxygen-silicon chain. How far this line of research will go and how successful it will be is yet to be determined.

I have avoided reference to the inorganic chemistry of fissionable elements deliberately rather than through oversight, because the Soviets' demonstrated success in this field has been obvious for some time.

Basic or fundamental research in theoretical inorganic chemistry has not been neglected. Studies in structure, stability, coordination compounds, oxidation-reduction phenomena, and so forth, have all received their share of attention in the land of Mendelejeff—one of the intellectual giants of inorganic chemistry.

In closing I should like to say that there is no great cause for concern that the quality of Russian-sponsored research in inorganic chemistry is superior to that of the Western world, but there is cause for concern in regard to the quantity of Russian-sponsored research in this field.

CHARLES R. NAESER
Department of Chemistry,
George Washington University,
Washington, D.C.

Low-Temperature Physics

Low-temperature physics cuts right across any subdivision we care to make of the field of physics, and one might wonder, therefore, why it is that there is a separate group who call themselves low-temperature physicists. The reason is historical and has to do with the fact that the production of very low temperatures was, until recently, a specialized technique, and that there were few institutions that could afford the effort or expense of a low-temperature installation. This is not true nowadays, however, and in fact most laboratories in the United States, both university and industrial, have access to liquid helium. This has been made possible mainly through the development, by Collins, just after World War II, of a convenient type of liquefier, through its commercial manufacture, and through the considerable sponsorship of work in low-temperature physics by the Department of Defense. This has meant that the volume of work in this field in the United States has risen tremendously since the war; in fact, one refers in a friendly way to previous work in the field as being "B.C."—meaning, of course, "before Collins." I mention this because it is important to realize what an enormous growth has gone on in this country in recent years, apparently greater than the growth in Russia.

In Russia, work in low-temperature physics began in the early 1930's. For example, at Kharkov there were, on the experimental side, L. and B. Ruhemann, who had worked with Simon in Berlin, and, on the theoretical side, L. D. Landau. Incidentally, we might anticipate a little here and note how many times the name of Landau, who now works in Moscow, appears in Russian work. This is less true of Kapitza, who first published from Russia in 1939, and who in fact wrote the first two articles in the then new *Journal of Physics of the U.S.S.R.* These were technical papers having to do with the construction of liquefiers.

With regard to the physics of low temperatures, perhaps the most striking and typical phenomena are the transformation of liquid helium into a superfluid phase and the transformation of many metals and alloys into a superconductive phase. The Russians have been working steadily in these two fields since the early 1930's. They have made their most striking contribution in the field of liquid helium, through work triggered by Landau and Kapitza.

Liquid helium is a strange substance, and some of its properties have been understood more easily and for a longer period of time than others. It remains a liquid down to absolute zero and does not solidify at all at normal pressure: yet it undergoes a phase transition at 2.2°K below which it is a superfluid. This startling property of superfluidity and all its ramifications received an explanation only in terms of a model. Such a model was developed outside Russia by Tisza in 1938 and in a different way by Landau in 1941. Landau claimed that his model followed from quantum mechanics, and although there seems to be a universal opinion that he never rigorously proved this, the model nevertheless has had great success. One of the most notable things was the prediction of a new kind of wave motion in liquid helium, called "second sound." It should be said that it appears that Tisza realized more clearly at the time that "second sound" is a thermal wave. It was only after an experimental failure in Russia to excite "second sound" mechanically, by Peshkov, that it was suggested that a thermal device would be much more efficient; Peshkov was then successful and was, in 1944, actually the first to excite "second sound." The key experiment in the attempt to decide between the two models, however, was one designed to measure the velocity of second sound below 1°K; it came out convincingly for Landau. Many other types of experiments which are well explained by the Landau model have also been performed with liquid helium.

There seems to have been no further attempt in Russia to put the theory on a more rigorous basis. In contrast, there has been further work in this country, notably by Feynman and others.

In superconductivity one should mention the theoretical work of Landau on the so-called intermediate state and the beautiful experiments of Shalnikov and Meshkovsky which followed and which were designed to test the theory. The subject deals with the destruction of superconductivity by a magnetic field and the splitting up of a superconductor into superconducting and nonsuperconducting domains. It is a theory of a macroscopic effect—that is, one involving a very large number of atoms.

As far as the microscopic, or fundamental theory of superconductivity is concerned, the problem does not seem to have been tackled by the Russians. This field is most closely linked at present with the names of Fröhlich and Bardeen and their co-workers.

There are many relevant fields in which the Russians have made very little effort—for example, in magnetism and very low temperatures, especially electron spin resonance which was discovered independently by Zavoisky in Russia in 1946 and by Halliday in this country. This has been a very fruitful field of research but does not appear to have been exploited very much by them. It has been at Chicago and particularly at Oxford where most of the development in this field has gone on. From it has come impetus for the growth of the new and interesting field of nuclear orientation, and experiments in this field include the recent one on parity nonconservation in β-decay. Then, too, I must mention the interesting and important technical device known as the solid-state Maser, which has also grown out of studies of paramagnetic resonance. The Russians do not appear to be publishing in this field.

The Russians have done very little work in the field of adiabatic demagnetization and the region of temperature below 1°K, although they seem to be exploiting the use of the rare isotope He^3 in this connection. On the whole, therefore, it seems that they have limited themselves to specific fields, particularly to the fields of liquid helium and superconductivity. It should be noted, however, that from the occasional theoretical paper which appears in a field outside the ones mentioned, one concludes that the Russians are very much aware of, and understand, the work in all fields.

Finally, I should like to say that physicists who have visited their laboratories are quite impressed, on the one hand by the energetic theoretical discussions which go on, and on the other, by the outstanding demonstrating and teaching equipment.

ERNEST AMBLER
Cryogenic Physics Section, National Bureau of Standards, Washington, D.C.

Nuclear Physics

My impression of the state of nuclear physics in the Soviet Union has been gathered entirely from the published literature available in Western libraries. I have never personally visited Soviet scientific establishments, but my reading knowledge of the Russian language has made it somewhat easier for me to obtain an over-all view of Russian scientific progress in this field.

A natural distinction imposes itself between theory and experiment in nuclear physics. In the former, Russian physicists, even before World War II, have always made important contributions comparable to those originating in other countries. Several excellent schools of theoretical physics exist in the Soviet Union. In all respects they are equivalent in quality of output to similar Western schools and, in fact, they show a considerable degree of originality and independence of thought.

In the field of experimental nuclear physics, on the other hand, quite a different situation is found, which, as we shall see, strongly indicates a special concerted effort along certain lines to equal and possibly top Western achievements. I shall omit from consideration the field of nuclear reactor physics and technology, where we have known, since the Geneva International Conference in 1955, that little if any difference now exists between the Russian and Western states of the art. In the high-energy (accelerator) field, virtually nothing was done in Russia prior to World War II. Only about four years ago the Russians suddenly and dramatically lifted a curtain of silence from an impressive array of machinery as well as from a three-year backlog of competent results obtained with it. A large number of specialists on linear accelerators, synchrocyclotrons, and synchrotrons (one of the inventors of the synchrotron is a Russian) are active in several institutes. The largest accelerator functioning in the world at present—a 36,000-ton giant yielding protons of about 10 billion electron volts—is located near Moscow.

A great deal of originality may be found in the auxiliary instrumentation developed for the detection of particles and processes initiated by these high-energy machines; some of these techniques are ahead of our own. Our visiting physicists in the Soviet Union were universally impressed by the excellence of the quality of engineering and instrumentation evident around these installations. A staggering number of different experiments set up at each machine exploit to the fullest the capabilities of each instrument. Few, if any, of these experiments, however, have been startling by their novelty. It is clear that no expense is spared in these enterprises. This is in stark contrast with the quality of the buildings, lighting fixtures, and other structures not immediately and directly connected with the scientific effort.

Even in the more speculative domains of still-higher-energy machines for the future, the Russian scientists are exploring unusual and highly imaginative schemes, some of which are evidently inspired by their efforts in the field of controlled thermonuclear reactions.

In my own field of low-energy nuclear physics or nuclear spectroscopy, however, I discern a considerable lag on the part of the Russian experimenters. Until recently, no results at all were forthcoming from any Van de Graaff electrostatic generators or cyclotrons in the several-million-electron-volt range of energies. In one special domain of nuclear physics close to my heart, for example, it was a Russian theorist who published the detailed theoretical basis of a certain excitation process of the nucleus. It remained the exclusive privilege of Western laboratories to confirm this theory experimentally, over the past three years, without *any* competition from Russian workers until less than a year ago. Such instances force me to the inevitable conclusion that special emphasis has been placed, in the Soviet Union, on the high-energy field, perhaps because of its greater glamor and international prestige. In the study of the decay of radioactive substances, on the other hand, a field requiring relatively few expensive instruments, the Russian physicists have been holding their own with respect to their Western counterparts since before the last war. In fact, they have even been using a number of detection schemes hardly used in other parts of the world.

Since my information comes mainly from the published literature, a word might be in order concerning this most essential adjunct of basic research. A great number of Russian journals report the Soviet findings. In addition, at least two West-European journals receive regular contributions in English directly from Russian laboratories. References are usually given freely and honestly to previous results by Western workers. The tremendous rate of Russian progress is easily gauged by the fact that, some years ago, perhaps 90 percent of all references given were to previous Western results, whereas today as few as 10 percent are in this category. In addition to the periodicals, great numbers of very useful monographs, compendia, lecture notes, and review articles are published, mainly at government expense, to judge from their low sales prices. Western scientific publications and books are speedily translated into Russian, and all visitors to Russia have been struck by the high degree of familiarity with Western results on the part of Russian physicists; the inverse situation certainly leaves much to be desired.

To sum up, then, I find that Soviet achievements in nuclear physics greatly overshadow those of other nations, with the exception of the United States, Canada, and Great Britain and of a few isolated laboratories on the European continent. In contrast to the situation in most other European countries, there seems to be a great pool of talented and trained manpower from which research physicists are effectively recruited.

G. M. TEMMER
Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C.

Agricultural Research and Production

Basic sciences. Soviet Agricultural research involving the basic sciences of chemistry, physics, soil morphology, general botany, and crop ecology formerly was adequate and of good quality, but most phases of biology have been distorted to conform with antiquated theories. Research in plant pathology in Russia has been very limited, but present interest in this subject is evidenced by the reprinting of the U.S. Department of Agriculture 1953 *Yearbook,* which dealt with plant diseases.

Some excellent research in plant physiology has been conducted in Russia, but since about 1930 much of it, particularly that dealing with vernalization, has been so distorted by the theories of Lysenko as to be worthless.

Excellent genetic and cytologic research was in progress up to the time that Vavilov was banished and Lysenko assumed control of plant research in Russia (about 1945). Since that time, discoveries that have been reported often have been obviously completely false or of extremely doubtful validity; this has created doubts regarding the authenticity of much of the remainder. Reports that wheat plants produced rye or barley grains and that corn plants produced sorghum heads are beyond the realm of belief.

Practical accomplishments. Crop breeding has been only moderately successful in Russia, a serious handicap having been imposed by unsound genetic theories. The application of the science of genetics speeds up progress and reduces the work involved in crop breeding, although it is not essential to ultimate success. Experiments in crop culture and in evaluating crop varieties have been extensive and formerly were conducted satisfactorily, but are very crude according to modern standards.

Crop production. A year or two ago, Khrushchev announced that the Soviet agricultural program had been a failure. Russian agriculture is badly handicapped by the absence of profit incentives to the producers, the result of collectivization. The Yugoslav and Polish governments learned that fact in one year, and undertook no further collectivization. Government controls, also, are too inflexible to meet changes necessitated by seasonal fluctuations in weather and by fluctuations in the availability of facilities and equipment. Russia was a leading grain exporting country before World War I but since 1918 has had surpluses of grain only in a few very favorable years. Russian agriculture cannot be expected to reach modern standards until the profit incentive is restored, and that would sound the death knell of Marxist doctrines.

JOHN H. MARTIN
Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.

Crystallography

Russian scientists are very active in many branches of crystallography. At the first postwar reunion of crystallographers in London, in 1946, the question of naming the proposed international journal of crystallography came up for discussion. The British delegation had suggested "Journal of Structural Crystallography," and the name had been agreed on by all but the Russian delegation. The latter remarked that, in their country, many phases of crystallography besides crystal-structure determination were actively studied—for instance, crystal geometry, crystal morphology, crystal growth, and crystal physics. Following this suggestion, the journal was called *Acta Crystallographica.* To our disappointment, no Russian paper has as yet been submitted to the journal.

With extremely few exceptions, all crystallographic papers by Russians appear in Russian journals. The most recent such journal in the field is *Kristallografija,* which the Academy of Sciences of the U.S.S.R. began publishing in 1956; its first six issues total close to 800 pages. Before this date, starting in 1945, works of the Institute of Crystallography were published in an annual volume, and, in addition, Russian crystallographic papers appear in a variety of journals dealing with physics, chemistry, geology, and metallurgy and also in the *Transactions of the Academy of Sciences.*

The Russians did not formally adhere to the International Union of Crystallography until 1954, the time of the Third International Congress, which was held in Paris. There the Russian delegation distributed hundreds of free copies of a special "Congress Issue" of the annual volume of the Institute of Crystallography. All the papers in this issue appeared in both Russian and French. At the Fourth Congress, held last summer in Montreal, the Russian delegation presented us with complimentary copies of a special issue of *Kristallografija.* Each paper appeared in Russian with a short English abstract. Another gift was a bound volume entitled *Crystal Growth* [375 pages; cost, 21 rubles, 40 kopecks (about $5.50)] containing 43 papers in Russian only. There seems to be no doubt in the minds of Russian crystallographers that we ought to learn their language!

In view of the quality as well as the quantity of Russian contributions, a reading knowledge of Russian has indeed become desirable. The thorough French abstracting service, during the first nine months of 1957, reviewed over 350 Russian crystallographic papers, which represent over 13 percent of the papers considered. The remaining ones came not only from the United States but from all other countries as well. It is interesting to note to what extent the Russians participate in the various fields of crystallography. As far as we know, they have not entered the field of neutron diffraction at all, whereas in crystal-structure determination by means of electron diffractions, they are leading by a wide margin. They are strong in the fields of morphological crystallography, crystallogenesis, and crystal chemistry (24 percent of 342 papers). Their interests appear to lie more in the theory than in its applications. They have neglected organic and biologic structure determinations almost entirely, although they have done a lot of work on minerals, metals, and alloys. Belov's laboratory is becoming a center for the structure determinations of silicates. The quality of this work has improved greatly in recent years, perhaps because of better instruments and computing facilities.

Only in the last few years have references to non-Russian publications appeared in Russian books and journals, but it has been evident all along that the Russians are up to date on what is being done elsewhere and, more important, that they make full use of all the findings of others. The same cannot be said for Western crystallographers. *Acta Crystallographica* contains almost no references to Russian works, and this is not the result of any editorial policy.

The U.S.S.R. is far ahead of the rest of the world in the teaching of crystallography. At least three universities (Moscow, Leningrad, and Gorky) have special chairs of crystallography. Specialists are trained in crystallography, crystal chemistry, and x-ray diffraction. They receive up to 680 hours, the equivalent of ten three-hour-a-week lecture courses and five three-hour-a-week laboratory courses in crystallographic fields. It is doubtful that this number of distinct courses in crystallography alone can be found in all the universities of this country combined. At the Madrid meeting of the Teaching Commission of the International Union of Crystallography in 1956, the Russians showed a movie of one of their courses dealing with crystal growth. Non-Russian members of the commission were speechless. No such course is taught in the United States. Where are these thoroughly-trained crystallographers employed? The best ones, is appears, work at the Institute of Crystallography, in Moscow. A Russian colleague who was asked how many full-fledged crystallographers were employed there answered, "about 200." There is no Institute of Crystallography in this country; indeed there is not even a department of crystallography in existence at any American university. Unless remedial action is taken now, American students of the coming generation who will ask their honest adviser, "Where can I get the best crystallographic training?" may have to be told the sad truth, "In the U.S.S.R."

J. D. H. DONNAY
Departments of Geology and Chemistry, Johns Hopkins University, Baltimore

Earth Science

Russians have been active for many years in various branches of earth science, particularly in geochemistry. Recently, their effort has increased dramatically in many areas, particularly those related to the International Geophysical Year. The satellites are only one facet of their program. A notable example is oceanography, where numerous ships are being employed. There are, for instance, the *Ob* (a vessel of approximately 10,000 tons), a second ship of similar size, numerous big ice-breakers, and a nonmagnetic ship, all under the jurisdiction of scientists. In contrast, our studies in oceanography are conducted principally in two converted yachts of modest tonnage.

Russian activity in the field of seismology is intense and successful. The crucial problem in detecting a distant disturbance is to achieve a high ratio of effect to local background. The lower the background the more effective the observing equipment. The Russians have made a great effort to discover quiet sites and have studied the effects of time of day, weather, and season on these. Thus, they have been able to achieve a vastly superior sensitivity of detection for distant disturbances, amounting to as much as 50 decibels more than our best performances. Part of the answer is that our research people generally work from 9 A.M. to 5 P.M. The good Russian records were made at 3 A.M. Furthermore, the effort in seismology is well coordinated with an extensive network of some 60 stations. Our work is conducted by individuals, with a minimum of cooperation.

Another area where a contrast exists is in geophysical studies in the Arctic. We have two stations, both new—one on an ice floe, another on an ice island. The Russians have at least 12 such stations and have had several for years.

Two problems of immense importance to survival in the Arctic are those of water and permafrost. We have two geologists working on a study of these topics. The Russians have scores.

Studies of paleomagnetism—the magnetism of ancient rocks—were initiated in this country about ten years ago. Today only a few men here are engaged in research in that area, while in Russia more than a hundred scientists are active.

Another measure of the over-all Russian effort is the size of the Institute of Physics of the Earth, in Moscow. It is one of many such institutes devoted to geophysics. Stationed at the Moscow institute alone are 300 scientists, a number which considerably exceeds the total in the whole United States of those doing fundamental research in geophysics.

In almost every area of geochemistry the volume of effort at least matches our own. In my particular specialty, geochemistry of organic materials, the effort of the Russians is perhaps four times as intense as that we are making. Schairer of our laboratory has recently reviewed papers in heterogeneous equilibria. He reports much activity in that area, particularly in studies related to earth science.

The activities of Russian geologists have been well supported. One of the problems of a field geologist is that he can often examine readily only the surface rocks. In areas where economic considerations lead private enterprise to drill, the U.S. Geological Survey may examine cores to obtain detailed information about subsurface conditions. Unfortunately, drilling for economic reasons is limited to a fraction of the area of the country. For years our Geological Survey has wanted to drill some holes where the purpose was simply to learn about the geology of a given region. Funds have not been available for this purpose. The Russians have a program for drilling 200 holes each year, at places selected by research geologists. These holes are located without reference to economic considerations and go through the surface layers down into the basement complex 1000 feet, with total depths often in excess of 10,000 feet.

In summary, it appears that, quantitatively, the Russian effort in fundamental aspects of earth science far exceeds our own. From the viewpoint of quality, the story is somewhat different. Part of the Russian work is excellent. Some is poor. For the most part, its quality is comparable to our own. A Russian geophysicist who recently visited many of our establishments in this country was amazed at the quality and quantity of our research output in earth science in view of the small numbers of active workers and of the evident lack of organization and support.

An important problem we face is that of communication of scientific ideas. Our scientific periodicals are speedily translated, and the Russian scientist often receives copies of our journals in his own language about as fast as we do. Thus, Russia has the benefit of our scientific progress plus its own. Although our translation program is improving, costs are still too high for the achievement of adequate widespread distribution among the working scientists of this country.

Another handicap is the relative cost and availability of technical books. Recently, a 15,000-copy edition of an 800-page book of geotectonics was published in Russia, selling for the American equivalent of about $3. The edition sold out within a month of publication. Were a similar book published in this country, it would sell at about $20. During the first year, 1000 copies might be sold, with perhaps 300 purchased during the first month, mainly by libraries.

PHILIP H. ABELSON

Geophysical Laboratory,
Carnegie Institution of Washington,
Washington, D. C.