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United States Science Policy: Its Health and Future Direction

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It is timely that this review of U.S. science policy is being held in December 1968 just before a change in the U.S. Presidency—a time when special thought and attention are being given within and outside of government to the health and future directions of U.S. science policy. For myself, I look forward to contemplating what "they" should do rather than trying to get things done myself in a very complex government.

In a sense, such review and evaluation is a continuous process, but I am struck by the fact that there have been discontinuities in this process at roughly 5- to 6-year intervals since 1940.

The first major appraisal of U.S. science came immediately after World War II. Under the Office of Scientific Research and Development we had built from scratch a magnificent team of scientists and engineers and an array of first-class laboratories. In 1945 we saw the scientific team being disbanded and the research facilities transferred to other auspices. These circumstances were the cause of much thought and debate, which produced such appraisals of the needs and deficiencies of American science as Vannevar Bush's *Science: The Endless Frontier* (*1*), which still makes good reading, and the well-known Steelman Report for President Truman.

In 1951, under the stress of the Korean War and the possibility of another mobilization of the scientific community, President Truman created a Science Advisory Committee in the Office of Defense Mobilization, to provide the President with independent advice on scientific matters, particularly those of defense significance. This was the first significant step toward moving scientific advisers into the White House.

Again in 1957, in the traumatic aftermath of Sputnik, there was a call for a general reappraisal of where we stood in our national science policies and goals and the adequacy of government science organization. It resulted in the appointment of the first full-time Special Assistant to the President for Science and Technology, James Killian. Simultaneously, the President's Science Advisory Committee was established in the White House.

Five years later, in 1962, after another study and review of the White House science organization, it was decided to establish the Office of Science and Technology (OST) to provide permanent staff resources to the President for dealing with matters involving scientific and technological considerations.

Now, 6 years after the OST was created, we are again at the crossroads of introspection and examination of our national science policy and the organization needed to formulate it and carry it out. It is my feeling that, as before, changes will be made—and, I hope, for the better.

Having spent the past 5 years at the bench of U.S. science policy development, I would like to review with you some of the issues and problems as I see them, with some thoughts as to the future.

The main problem areas have been perceptively identified by the OECD (Organization for Economic Cooperation and Development) examination of U.S. science policy: academic science and the universities, the role of the government in industrial research, some of the social impacts of U.S. science policy, and the adequacy of the mechanisms in the U.S. government for dealing with these problem areas—that is, to make science do for the intellectual and material welfare of the American people all the things we think it can do and that we claim for it.

Federal Support of Academic Science

With regard to academic science and the universities, the central questions are: first, how to provide training of high quality for enough scientists and engineers of the right kinds; second, how to maintain vigor and creativity in the basic research establishment; and third, how to set priorities and determine the relative emphasis given to different research areas.

Concern over maintaining the vigor and quality of academic science is not a new phenomenon in 1968. At each of the 5- to 6-year steps in the evolution of the government science structure to which I referred there was a peaking of public concern about the state of American science. I venture to say that this recurrent, if not continuing, concern will remain with us for the foreseeable future.

You will recall the pronouncements after World War II about the sad state of fundamental research in the United States and our unhealthy dependence on European scientific discoveries for the development of the U.S. arsenal of

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new weapons, most notably the atomic bomb. The case for substantially strengthening the ties of government to university science was eloquently stated in Bush's *Science: The Endless Frontier*, in July 1945.

The year 1950 finally saw the creation of the National Science Foundation, after long debate (and a Presidential veto) over how independent this so-called independent government agency should be.

Again in 1957, wtih the advent of Sputnik, there was a resurgence of concern and interest in academic research, particularly in terms of the production of new scientists and engineers with advanced training, partly out of fear that the rapidly increasing output of scientists and engineers in the U.S.S.R. would pose a long-term threat to U.S. security.

When I entered the White House scene I was confronted with the issue of academic science in a somewhat different form. The explosive growth of government support of science in the 1950's and early 1960's had left in its wake a new array of problems of science administration, both in the universities and in the government. There was evidence of congressional dissatisfaction with what they believed to be lack of tightness and tidiness of federal controls over these large expenditures. This was, in part, based on misunderstanding of the nature and form of federal support. The question of overhead rates charged by the universities was raised, apparently from a confusion of overhead and profits—a question, I must admit, that has not been swept away (witness the recent Mansfield amendment to limit indirect costs paid under research grants).

Members of Congress had become acutely conscious that university science had entered the big league of congressional interests. The House established a Select Committee to Investigate Expenditures for Research Programs. The House Science and Astronautics Committee moved to establish a permanent Subcommittee on Science, Research, and Development. The Congress debated ways of strengthening congressional mechanisms for obtaining information and advice on scientific and technological fields.

Today there are again mutterings about a "crisis of confidence" in federal support of academic research. As in the past, this appears to be another moment of introspection, calling for self-renewal and readjustment of our sights to see clearly the goals ahead.

The current problems of academic science *appear* to have their origins in the budget stringencies growing out of the Vietnam war. But, in my view, the budget squeeze is only one symptom of a more general difficulty. It has brought to the surface the latent, unresolved problems which must inevitably be dealt with directly. I refer to such issues as the support of research through project grants versus broad institutional grants, and how to wed the cultivation of the best science to the training of enough scientists, broadly distributed throughout the country. Even more fundamental and serious is the failure of the university and the scientific community to effectively communicate its values, its purposes, and its contributions to the public and to the lawmakers.

Although these and other problems connected with federal support of academic research could be alleviated by increased funds, it is unlikely that there will ever be enough funds to satisfy all legitimate requests. In short, we had better face up to the underlying problems. With the increasing size of the academic science establishment and the proliferation in the number of promising avenues of research, failure to develop a coherent approach could bring even greater pain at a later date should the enterprise suffer a loss of public confidence and support.

As we move to unite the knots in the existing policies and arrangements for federal support of academic research, we must, I believe, find a healthy accommodation between a laissez-faire system and centralized control. Forces in the direction of detailed planning of basic research and graduate education have been resisted because of the inherent unpredictability of the results of scientific research and the needs of our society, and because of difficulties in estimating the long-term national requirements for scientists and engineers. While I agree that central direction of federal support of academic science is not conducive to the maintenance of vigorous, high-quality academic research, neither is chaos. Nor can we entirely capitulate to the vested self-interests in subgroups of the scientific community that will resist any change or trade-off that they believe would threaten their interests. What I am suggesting is a better articulated framework for federal support of science and an indicative plan, looking a few years into the future, that will provide a general guide for the allocation of funds, at least, and provide a necessary degree of stability and predictability for future planning by the universities and the government agencies involved.

There are many ways in which the federal support of academic science can be carried out—different mixes of government agencies and universities, as well as different mechanisms for the support of research and for the support of graduate training. What may make sense at one level of consideration may not make sense at another level. I believe that we do not know enough about the interrelationships of the various parts of the scientific enterprise, the various types of support, and the various objects of support to construct a comprehensive blueprint or plan for proceeding. However, I am convinced that we need to sharpen our analytical tools and capabilities, identify and acquire the necessary data, devise working hypotheses, and be willing to experiment with subaggregates of the system so that we will be in a steadily improving position to deal effectively with the entire set of problems. And we will have to move further toward the generation of broad-scale, long-range plans.

This problem can be likened to the continued, healthy growth of a delicate and complex organism. It is not analogous to the stages of human growth from childhood to adolescence, adulthood, and old age—and I hope the latter is not in sight. Rather, it is more like the problems of medicine and physiology, where we understand some of the pieces, but where our understandings are isolated and do not explain the functioning of the organism as a whole. The pieces I refer to are basic research, education, applications, and their coupling to technology. Our job is to make the organism healthier—not just its component organs.

Impact of the National Scientific Effort on Social and Economic Progress

A question just as fundamental as that posed by academic science concerns the coupling between the national scientific effort and our country's social and economic progress.

During the past 2 years I have been deeply involved in two studies of the so-called "technological gap" issue. One was carried out at my direction within the U.S. government. The other was undertaken by the Organization for Economic Cooperation and Development, in Paris, in preparation for the OECD Ministers of Science meeting last March. The analysis of technological disparities among industrially advanced countries and their basic causes makes it clear that the United States does better than most countries in harnessing science and technology to economic and social progress.

Europeans tend to regard the technological gap as a new phenomenon, and in doing so overlook the long history of U.S. preoccupation with industrial growth. There was considerable debate on this issue among the "founding fathers" after the American Revolution. According to George Soule, in his *Economic Forces in American History* (*2*), Thomas Jefferson favored a nation of landowners, principally engaged in farming, to avoid the poverty and exploitation of the working classes which accompanied the beginning of the industrial revolution in England. In this debate, Alexander Hamilton's differing views prevailed, and Hamilton should be credited for the strategy America used to overcome its technological dependence on Europe. The basic elements of this strategy, reflected in Hamilton's "Report on the Subject of Manufactures," submitted to Congress in 1791 when he was Secretary of the Treasury, were the protection of "infant industries." Perhaps more importantly, he urged the promotion of immigration of technologically skilled manpower and the encouragement of capital inflow from abroad. Since that early time, numerous European observers, from Alexis de Tocqueville on, have commented on the positive American attitudes toward technological change and the introduction of new technology in industry.

Federal policies and programs aimed at stimulating American industrial technology, directly or indirectly, are simply the modern version of Hamilton's infant-industry argument. What makes it more difficult now is that we are trying to strike a balance between a national view and a world view. In Hamilton's day, government policies toward satisfying the needs of 10 million people couldn't upset any international applecarts. Today, the currency and the military power of the United States are dominant forces in the world of commerce and international order. Government policies with short-term domestic objectives can, through international repercussions, have longer-term adverse effects on both the international and the domestic scene—witness the run on the dollar due to what others regard as overexpansion of domestic programs.

Despite the acknowledged American success in most fields of science and technology, there are some industrial people in the United States who feel that the effect of our emphasis on academic science has been to draw off too many talented people from other creative functions of society, such as industrial engineering and innovation. They feel, for example, that contemporary engineering training is not appropriate to the conduct of engineering in industry—although others dispute this allegation.

Another difference of view concerns the degree of coupling of the results of government-financed research and development, particularly in the military and space areas, with the needs of civilian industry. Again, some will allege that the federally financed research and development effort has siphoned off or otherwise deprived industry of creative talents that could be put to use in commercial R&D—that it has undesirably inflated the salaries of scientists and engineers employed in nongovernmental commercial business.

With regard to the "spin-off" question, almost everyone who has looked at the evidence agrees that the exploratory development programs of the Defense Department and NASA have enabled us to press the technical arts to their farthest limits. Some of our best, newest, and most thriving industries have their roots in this government-financed industrial activity. Our favorable export balances largely reflect export of products born of intensive technological effort in industrial sectors such as sophisticated electronics, computers, and aircraft, which owe much to the stimulation of federal support. But we remain unclear about the diverse effects of federal support of research and development in the aerospace and electronics industries on our industrial base as a whole. The dual fads of enthusiasm and complaint about "spin-off" are not likely to be dissipated without further intensive study of the complicated cause-and-effect relationships observed over a considerable period.

One could advance the hypothesis that, in a sense, technology per se is to industrial innovation what science is to the generation of new technology—that the general search for new technology is the industrial equivalent of basic research. In my view, though, there is an important difference between science and undirected technology. The best basic research is directed at carefully conceived problems framed by the investigator. I question whether government programs aimed at the general development of new technology would be effective in advancing civilian-directed industry. On the other hand, technology which is a product of industrial R&D contracts aimed at satisfying the exacting requirements of military and space systems—requirements which go well beyond civilian needs and which set concrete performance goals for the product—is more likely to be applicable. We have just witnessed a magnificent demonstration of this point in the Apollo 8 mission, in which the huge Saturn V had to perform flawlessly on its first flight, as did computers, a far-flung communications and tracking system, and a complex human organization—not to mention the astronauts themselves. This distinction between general technological development and the achievement of measurable goals was not well brought out in the OECD studies and seems to have been blurred in some foreign debates on government programs for strengthening the technological base of industry—say, the computer industry.

It should also be observed that technological development is enormously expensive as compared to most basic research, and that, although the Department of Defense, NASA, and the Atomic Energy Commission, among others, do support exploratory development efforts, development can normally be supported as a federal expenditure only where it is aimed at specific needs that the public, expressing itself through the Congress, regards as commensurate with the investment. This, of course, raises the $64 question of the appropriate role of the U.S. government in supporting or promoting research and development for the prime purpose of advancing industrial development and growth for civilian ends.

Although there is general satisfaction with the health of American industry and its rate of technological innovation, there are some areas (environmental pollution is an example) where the ordinary market rewards do not stimulate industry to develop at an adequate pace the new products and processes needed by the general public. In the field of air pollution there is a lack of strong private incentives, and the urgent need for improvements in pollution-abatement technology have called for government leadership.

The leadership for pollution abatement, as present, lies in the government through its role in standard setting and in supporting science and technology to demonstrate what can be done, and how. It will be the essential job of industry to find cheaper and improved ways of applying the new technology. In the longer run, this is bound to lead to an increase in private activity and a lessening of the financial burden on the government.

Government standard-setting has been an important indirect means of stimulating industrial incentives and competition to improve the quality of products affecting other aspects of the general health and welfare. Through food and drug legislation we have been able to maintain high standards of drug safety and efficacy. Automobile safety standards are another example. Within the interval of a few years we have seen a dramatic shift in the attitude of the automobile industry from a phobia about mentioning automobile safety in advertising to today's promotion of safety features in meeting industry competition.

A great deal more work needs to be done to sharpen the tool of standard-setting as a means of introducing product improvement and change in particular sectors of industry. Standards must be based on sound scientific evidence, which must be continuously reexamined and improved. They must be set with regard to the industry's economic, managerial, and physical ability to respond. If there is careful regard for the sensitive interaction between incentives for innovation and requirements for protection, government standard-setting can exert a strong motive force for private investment.

At the same time, when looking to industry one should be realistic about the size of the market incentives needed to stimulate private investment. The expected market demand or dollar sales volume must be large in relation to the R&D investment that can be justified to produce the improved product.

In some areas it will be necessary for the government to directly stimulate industrial innovation in important but lagging industries. In some cases it can do this as a consumer of a large number of units (such as military housing) or through partial or full support of research, development, and demonstration projects.

The question of whether there is need for an overall governmental policy for strengthening civilian technology generally has been held in abeyance. In the absence of a direct interest in a specific industry or social problem, the government has not adopted, as a general approach, direct measures for encouraging industrial invention and innovation per se. Patent and tax incentives have long provided indirect encouragement for private investment. With the exception of selected industries somehow identified with the public interest (for example, agriculture, atomic energy, the supersonic transport, water desalting, pollution abatement, and a few others), the government has not subsidized civilian-oriented industrial research. Further measures to stimulate technological innovation may be needed, but there appears to be no need for an across-the-board, direct approach by the federal government. Nonetheless, we should watch closely the experience of Canada, the United Kingdom, and France in their new programs for subsidizing the development of new civilian technology, to see whether experiments along this line are indicated for the United States.

Government Science Organization

Thus far I have dealt with some of the issues that academic science, industrial research, and social needs pose for U.S. science policy. The fourth question asked by the OECD examiners is even more elusive: how adequate is the organization of the federal government for dealing wtih these questions—particularly, how adequate is the organization at the Presidential level?

I believe we have the right basic ingredients. The Office of Science and Technology has grown steadily; it now has a staff of over 50, more than 20 of them professionals. This high-quality staff works closely with the agencies, with the Bureau of the Budget, with the National Security Council staff, with the Council of Economic Advisers, with the White House staff, and with the committees of the Congress. Its central concern is the evaluation of existing and potential programs, the coordination of agency programs, and participation in the larger discussions of priorities and emphases. On selected major issues it benefits from the external advice of the President's Science Advisory Committee and over 200 consultants. Internally it draws on the expertise and experience in the agencies through the Federal Council for Science and Technology and its panels.

But I believe OST and the Science Advisory apparatus need strengthening. Before I get more specific, I would like to caution that the easy answer to all problems in government, scientific and nonscientific, seems to be to move them closer to the President. I do not think that answer is tenable for many things —he is already overburdened.

My first guiding principle as regards government science organization (and most other organization) is this: decision-making should be pushed to the lowest responsible level appropriate to that decision. I question the wisdom, for example, of asking a high-level group to make decisions which could be made by a laboratory director. On the other hand, there is an important class of problems that involve general questions. In my view, the more general the question is, the more it should approach the center of the decision-making apparatus. For example, one function that can best be performed at the center is overall planning. Today we are facing a set of problems involving science and technology, and their interaction with many institutions and sectors of our society whose dimensions extend well beyond the capabilities or jurisdiction of any single department or agency of the federal government. I believe that the development of a greatly improved capability to analyze these complex problems and to foresee their eventual impact on society will be an important step in the evolution of the science organization at the presidential level. Such analysis must be carried out without the initial constraints of agency jurisdiction, and in intimate relationship with the decision and policy-making processes in the Executive Office of the President.

It is clear that we need more systems analysis on a government-wide scale. I do not mean the formal and sometimes sterile approach of professional systems analysts. Rather, I refer to analysis that is both tied to the decision-making function and involves the creative thinking of a large number of people looking at the inventive process, without undue concentration on the techniques and methodology of systems analysis.

There are many basic questions facing the government that we have been unable to analyze in a systematic way —questions like these: How many graduate schools, of what kind, does the country need to meet its present and future needs? What is the effect of the various development programs on the future requirements for research support? What trade-offs were we really making when we initiated a space program, and what trade-offs will we be making if we cut it back now? We need studies like these as part of a continuing assessment program. The Office of Science and Technology could eventually evolve into an office of planning, evaluation, and analysis, looking broadly at national problems with some scientific or technological component but extending well beyond the purely technical areas. The OST has been moving in this direction in its work in environmental pollution, urban needs, and the world food problem.

In fact, OST has a newly formed Office of Energy Policy Coordination which is undertaking a broad study of the many important energy policy questions that affect more than one agency of government. The new policy questions are occasioned by the rapid advance of nuclear power on the energy scene; the need to reconcile air-pollution and water-pollution programs with our demand for low-cost energy; the growing demand for energy in relation to available supplies at economic prices, especially supplies of natural gas; the basic question of future import policy concerning oil, gas, and uranium; government policy toward developing sources of oil and gas from shale and coal to supplement natural supplies; and many others.

As I have indicated, an essential feature of such studies is that they be carried out in such a way that they are an integral part of the policy-making process; that they deal with the real world economic and political constraints, without accepting them as immutable.

Such an evaluation capability should be part of the forward planning function that needs more explicit recognition in the Executive Office of the President. By "planning" I do not mean a rigid blueprinting of the future. Rather, I mean a best current projection of the future, and of alternative futures, based on present activities and planned new ones. We simply are not smart enough to put together large-scale plans for many things at the present time. However, by developing a capability for analysis, it should be possible more and more to chart the future analytically rather than through mere intuition and debate.

There are some things that cannot be done without large-scale planning. A national telephone system required an overall plan, and systems analysis and engineering were needed to put it together. We have undoubtedly foregone some competition in the process, and perhaps some of the components are more expensive than need be, but the need to eliminate internal incompatibilities was overriding. Similarly, despite the political fragmentation of many communities, water and sewer systems must be put together according to a plan. For large-weapon or space-systems development, the complexity of the many efforts which must jell, with a lead time of 5 years or more, requires a working plan. Many more big national problems are forcing us in this direction. The structure of university science may well be approaching that divide where the need for overall systems planning will take precedence over the goal of obtaining maximum health of each of the parts taken one at a time.

Undoubtedly, we will have to face up to the need for more comprehensive planning. We can begin—in fact we already have begun—to isolate those manageable pieces of the larger problems that lend themselves to analysis, and, as further areas yield to analysis and we better understand the boundary conditions, it should be increasingly possible to predict likely outcomes from given actions.

Of course, as scientists we recognize that the best of analysis cannot predict the outcome if we do not know the relevant inputs, or, as is so often the case in complex problems, when we are not even sure that we know what all the relevant variables are. In such situations we rely on the carefully controlled and evaluated experiment. The experiment is the lifeblood of science, and we must learn to use it effectively in other areas. For example, in dealing with urban problems we must learn to employ experiments to help answer the larger questions that do not yield to analysis.

We shall have to foster many experiments involving large systems, but naturally we need to know how we will evaluate them when they are finished. Rational analysis coupled with experimentation should make it clearer what we need to do by experiment and what choices are available through analysis. Unfortunately, we have too often substituted bureaucratic and political processes for either rational planning or experimentation. In a democracy this may always be the case, but the analysis will at least provide a better basis for political discussion.

A second principle of government policy ought to be to maintain competition. Insofar as government actions and organization are concerned, many people now suggest a highly planned economy for science, with a rigid separation of functions and a careful elimination of duplication. Our successful experience suggests a contrary course. Most government agencies that have remained virile and avoided deterioration have done so, in part, by stepping on each other's feet. As a general rule, if there is a large opportunity or need at stake, it is profitable and appropriate to employ both competition and careful planning.

More importantly, basic science is both a cooperative and a highly competitive activity. Its progress depends on the stimulation provided by competition. For a vivid illustration I refer you to James Watson's fascinating book *The Double Helix* (*3*). In science, as in economic processes, competition stimulates the quality of performance and must be fostered, together with the cooperation which comes through an open, widespread, and effective communication system among scientists.

Proposals

Finally, I want to make some specific proposals.

First, I believe the Office of the Science Advisor needs strengthening, not only through more staff capability for analysis and planning but through the addition of full-time top-level people. In short, I propose that the Science Advisor be made the head of a three- to five-man Council of Scientific and Technical Advisors. My reason is simple—the range of matters he must at present consider is so broad and his responsibilities are so extensive that he needs help. Alternatively, one might add three assistant directors to the present director and deputy director.

I also believe that, provided the staff resources were available, it would be wise to ask such a council to submit to the President and the Congress an annual report on the state of U.S. science and technology, roughly analogous to the annual Economic Report.

Second, we should reexamine a possibility we put aside some years ago—namely, that those scientific activities not tied to the central purposes of an agency be considered for inclusion in a department of science, with the National Science Foundation as a core. Science has now assumed such importance to the nation that its position would be stronger if it had a voice at the Cabinet table.

However, in making that proposal I want to make it clear that I would *not* consider concentrating *all* of our science activities into a central agency. A strength of the American establishment is the realization that *science is part of everything*. Those research activities which are integral to a department's mission or which form the basis for its future should be left where they are. More than that, agencies should be encouraged to strengthen their research and development base. But there are other scientific activities of agencies which may be somewhat peripheral to the main job of an agency but are nonetheless important, and these would flourish if transferred to a department of science.

In determining the organizational elements of a department of science, thought will have to be given to the department's relationship to advanced education on the one hand and technological advance on the other. The more the department is oriented toward new technology, the less it is equipped to deal with academic science and advanced education, including the humanities. The more it is oriented toward basic research and academic science, the more it is fitted for a broader role in higher education. On this score, one could invent several cuts that would represent an improvement over the present situation, but I am far from sure what the best cut would be. My present feeling, though, is that the critical questions concern basic research and higher education, and that technological development is more appropriately conducted by agencies with specific tasks and missions.

In the power equation of Washington, such a department of science, if it is to be influential, should have a budget of $2 billion or more. Its principal officer would have line responsibility and public accountability and, most importantly, the interest and confidence of the President, the attention of the Bureau of the Budget, and the ear of the Congress.

With a strong cabinet officer for science in the Executive Branch, there would automatically be a strong congressional counterpart committee having a broad interest in the problems of science and technology, not a minor or incidental interest. We already have committees like the Joint Committee on Atomic Energy and the House Science and Astronautics Committee that are broadly educated in particular spheres of scientific and technological activities, and I am confident we could have committees of this caliber to supervise this department too.

Conclusion

Both the problems and opportunities facing government science policies loom larger than ever before us. I have been privileged to have had a part in setting U.S. science policy and am proud of what has been accomplished so far.

Despite the last 25 years' evolution of the U.S. science structure in the U.S. government, we are still in the early stages of learning how to realize the potential of science and technology for the national good. But we have built a strong foundation, on which further additions and structural changes can be made wtih confidence.

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Brazil-Gabon Geologic Link Supports Continental Drift

Newly discovered tectonic province in Brazil matches province in Gabon.

Gilles O. Allard and Vernon J. Hurst

The idea that continents now separated by thousands of miles of oceans once could have been united is more than a century old. A reconstruction of the earth's crust before the drift occurred, very similar to that of Carey *(1)* and Bullard (*2*), was published 100 years ago (*3*). Wegener's papers and book (*4*) did much to popularize the concept in Europe. North American geologists remained rather cold to the idea until the geophysicist brought out strong arguments based on paleomagnetic studies (*5*).

At a symposium on continental drift in London in 1964, Bullard (*2*) predicted that some of the most important data bearing on continental drift would probably come from detailed comparative geological studies of geometrically matching areas which have structures truncated at the continental margin. Humphrey and Allard (*6*), working in Brazil from 1959 to 1964, discovered a Precambrian tectonic province trending roughly S70°E and apparently truncated by the Brazilian coast (Fig. 1). This pointed to a specific locale where a field test of the theory of continental drift might be made.

Geology of the Brazilian Area

Detailed mapping around the Itabaiana Dome in Sergipe, Brazil, by Humphrey, Allard, and others and reconnaissance mapping by Humphrey and Allard in the states of Sergipe and adjacent parts of Bahia and Alagoas, established the presence of the important Precambrian Propria geosyncline, trending N70°W, nearly normal to the trend of the Precambrian basement as formerly represented on the geologic

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