have given the structural and tectonic geologist a treasured piece of knowledge—an insight into how rocks are deforming in response to displacements at plate boundaries. Lynn's other contributions include work on nuclear explosion detection and a series of papers on seismic wave attenuation at plate boundaries and around descending lithosphere slabs. More recently, his work has included the problems of intraplate deformation and earthquake prediction. Notably, his work on the seismicity of the Adirondacks and adjacent regions of New England and upstate New York has involved verification of the Soviet discovery of preseismic changes in V_p/V_s ratios and has led to work with the New York State Environmental Protection Agency and Geological Survey on earthquake risk in the state. Lynn's heavy administrative duties at Lamont and his involvement in numerous national and international committees do not appear to have lessened his scientific productivity. He is a man who combines sheer hard work with originality and ingenuity.

Tectonics, Walter Bucher's lifelong interest, has moved into an exciting new era that has been created, to a large extent, by the work of Lynn Sykes.

Mr. President it is with great pleasure that your committee presents Lynn Sykes for the award of the Bucher Medal.

John F. Dewey

Acceptance and Response

I feel that it is a very great honor to be awarded the Bucher Medal by the American Geophysical Union. I feel particularly proud since both Bucher and I have had a long association with Columbia University. Looking around the audience, I am very happy to see many friends and associates with whom I have worked. I am especially happy about the kind remarks made by John Dewey, since he is a person that I consider to be a very good friend and whose scientific work I admire most highly. The last several years have been a very exciting time to be a part of geophysical research. These indeed have been interesting times with the developments in plate tectonics and earthquake prediction. There are several individuals that I would like to mention who have had a significant role in shaping my scientific career: William Brace of MIT, under whom I took a beginning course in the earth sciences and subsequently courses in structural geology and rock mechanics; Eugene Robertson, who provided me with a very stimulating job in the U.S. Geological Survey following my freshman year at MIT; and David Griggs, a former Bucher medalist, who has given me a great deal of encouragement over the years ever since he heard my paper in 1966 on the mechanisms of earthquakes and the nature of faulting on the mid-ocean ridges. In addition, I very much value the great stimulation I have had from many colleagues at the Lamont-Doherty Geological Observatory.

I feel fortunate that of all the named medals presented here, Walter Bucher is the only one I have known. Bucher had retired from teaching at Columbia University shortly before I became a graduate student there in 1960. I was fortunate in hearing several invited lectures which he presented when I was a graduate student. I remember his immense energy and excitement. I am very honored to receive the Bucher Medal.

Lynn R. Sykes

James B. Macelwane Award

to

Dan McKenzie,
Gerald Schubert
and
Vytenis M. Vasyliunas

in recognition of significant contributions to the geophysical sciences by a young scientist of outstanding ability

Dan McKenzie

To those earth scientists who have followed the revolutionary development of plate tectonics from its dawning, it may come as a surprise that Dan McKenzie can have done so much and still be young enough to qualify for the James B. Macelwane Award. Nonetheless it is so. He was born on February 21, 1941. He received his advanced education at King's College, Cambridge University, and was awarded a B.A. in 1963 and a Ph.D. in 1966. He became a Fellow of the college in 1965. He was fortunate enough to be a student in Edward Bullard's Department of Geodesy and Geophysics just in those exciting years when the validity of sea floor spreading was demonstrated. McKenzie was one of the first to realize the broader implications of the computer fitting of continents by Bullard and others which assumed that the drifting crust is rigid.

In 1967 Dan McKenzie and R.L. Parker analyzed the orientation of slip vectors of earthquakes at the margins of the North Pacific and demonstrated that they follow small circles around a single pole. Thus the vast Pacific plate is rotating as a rigid body. Jason Morgan, using a different approach, simultaneously showed that motions had been rigid in the past. Plate tectonics, the immensely fruitful quantification of tectonics, was born. Dan McKenzie pursued the important implications of rigid motions during 1967 and 1968 while he was a resident associate on the campuses of the California Institute of Technology, Scripps Institution of Oceanography, Lamont-Doherty Geological Observatory, and Princeton University. With Jason Morgan he analyzed the very basic relationships in the evolution of triple junctions, a study which has provided a theoretical framework for unraveling the geology of such complex regions as California.

Dan McKenzie soon turned from the elegance of plate geometry to the complexities of the real world. Utilizing seismology, he showed that very small plates in the Mediterranean region are moving rigidly and thus that plate tectonics concepts can be applied to deformation on the scale mapped by geologists in individual mountain ranges. Moreover, he found how irregular continents produce a smooth suture by lateral motion of small plates. He took to sea to map the fracture zones and magnetic anomalies of the Indian Ocean in collaboration with John Sclater and R.L. Fisher. This field work led to a notable study of the complicated history of the region since the Late Cretaceous, a history that included the migration of India and a major change in direction of plate motion.

McKenzie's thesis was concerned with the viscosity of the lower mantle, and he published some of his first papers on heat flow, gravity anomalies, rotation, and mantle convection. Thus he was ideally prepared to analyze the possible causes of plate motion as he has done in a series of major papers, beginning with 'Speculations on the Consequences and Causes of Plate Motions,' in 1969, and continuing through studies of heat flow and numerical modeling of convection.

Recently, he has integrated theory and observation in new ways in a series of papers that relate gravity, bathymetry, heat flow, and convection. The subsidence of a cooling lithosphere has important consequences for the early history of the opening of the South Atlantic, and uplift over rising mantle plumes accounts for the elevation of Iceland and the Azores.

Thus Dan P. McKenzie is at the forefront of plate tectonics now, as he was at the beginning.

H.W. Menard
(Read by Don L. Anderson)

Acceptance and Response

Mr. President, ladies, and gentlemen, it is a great honor and encouragement to me to have been chosen for the Macelwane Award for the work I have done on plate tectonics. My interest in the subject started when I was a graduate student at Cambridge, supervised by Edward Bullard, and it was largely through his encouragement that I abandoned my attempt to be a respectable theoretical physicist and joined what soon became a major bandwagon. But I would not have been able to do the work which results in my being here today without the generosity and encouragement of American scientists, who have flown me across the Atlantic many times and supported me in my work here. It is this which has allowed me and a number of other Europeans to make a contribution to modern geophysics. We are now trying to transfer the same generous internationalism, which we have learned here, to European institutions. It is fitting that I should be able to receive this award, in person, because Frank Press, wearing a different hat from the one he has on today, has supported my visit here this summer.

Dan McKenzie

Gerald Schubert

A scientist who has made profound theoretical and interpretive contributions in such varied subjects as plasma oscillation and turbulence, stabilities of flows in stellar interiors and planetary atmospheres, planetary geodesy, evolution of planetary topography, geodynamics of the earth's mantle, and the complex theory of the interaction of the solar wind with the moon might consider this a comprehensive contribution for a life of scientific research. The recipient of the American Geophysical Union's 1975 Macelwane Award has achieved all this, and more, in the course of virtually the first decade of his full-time scientific career. Although he has written over 100 scientific papers since 1961, this man has simultaneously been a mainstay of the undergraduate and graduate teaching program at the University of California at Los Angeles. Here he has offered a series of demanding fundamental courses in continuum mechanics, electrodynamic theory, and planetary physics. He has also trained and successfully launched several younger scientists on fruitful careers in planetary science. Geophysics has benefitted from his service on NASA committees dealing with Venus and Mars exploration, his participation on the Lunar Advisory Committee, and his careful and incisive judgments as an Associate Editor of the Journal of Geophysical Research.

This year's Macelwane Award recipient attended Cornell University as an undergraduate, being supported by a Naval ROTC scholarship. He completed work at Cornell in 1961, receiving a bachelor's degree in engineering physics and a master's degree in aeronautical engineering. His first paper published in *Physics of Fluids* was written with a then assistant professor of aerospace engineering, Donald L. Turcotte, and dealt with electromagnetic waves in a plasma. With his wife, Joyce, and a new naval uniform he entered military service at the Naval Nuclear Power School, Mare Island, California, as an instructor. Incredibly, this young naval officer then both took courses at the University of California at Berkeley and completed a thesis on turbulent fluid flow, in the Department of Aeronautical Sciences, all the while teaching nuclear reactor physics to members of the fleet. In 1965 he spent a year in the Department of Applied Mathematics and Theoretical Physics in Cambridge, England, as an NAS-NRC Fellow. He was appointed to the faculty in planetary physics at UCLA the following year.

His contributions to planetary and earth science have been profound. His 1970 papers with Young and Whitehead led to an explanation of the 4-day atmospheric circulation on the planet Venus. Also in 1970 his papers with Donald Turcotte and Ronald Oxbourgh demonstrated the importance of solid-solid phase changes to mantle-wide convection and have been a milestone in our understanding of the geodynamic processes of the earth's interior. He has been the principal architect of the complex analyses and syntheses of the Apollo lunar surface, Apollo subsatellite, and Explorer magnetometer data. His development of the inversion procedures has led to the unraveling of the difficult problem of the interaction of magnetohydrodynamic waves in the solar wind with the moon. Working with Schwartz, Colburn, Smith, Russell, and Lichtenstein, he has accomplished work leading to knowledge of the electrical conductivity profile within the moon, and hence an important application of the data of Sonett's lunar surface and Coleman's lunar orbital experiments. His careful analysis of the lunar magnetic data led him to discover anisotropic conductivity anomalies on the lunar surface.

Those of us who have worked with Gerry have recognized his quiet and thorough competence and his heavy commitment to first-class science. We are happy to honor him publicly today. Mr. Chairman, officers of the American Geophysical Union, ladies, and gentlemen, may I present Gerald Schubert, recipient of the Macelwane Award.

Thomas J. Ahrens

Acceptance and Response

I am deeply honored to have been chosen as one of this year's recipients of the Macelwane Award. It is especially gratifying to have been considered together with my corecipients, Dan McKenzie and Vytenis Vasyliunas, whose work I have respected and benefited from. In preparing a response to an award such as this, one immediately reviews the record of one's research and is reminded of the crucial role played by colleagues.

I have been especially fortunate to have studied under Donald Turcotte while obtaining my master's

degree at Cornell University and to have worked with him over the years on many research problems related to the thermal and mechanical state of the earth's interior.

I am grateful to Peter Goldreich, with whom I attended Cornell as an undergraduate and who later stimulated my interest in geophysics and was instrumental in bringing me to UCLA.

Geophysics at UCLA is a field of strength with many distinguished members, both past and present. I have derived a great deal from them all, particularly William Kaula, whose ideas have greatly influenced my own thinking about the physics of the earth and moon.

Finally, I must acknowledge my colleagues in space physics, Charles Sonett and Paul Coleman, Jr., whose measurements of the lunar magnetic field have been a source of much of my research over the past few years.

We live in an era of exploration of the earth and planets in which new and profound discoveries continually challenge our understanding. Hopefully, in the years ahead, I'll be able to continue making some contribution to the exciting science of geophysics.

Gerald Schubert

Vytenis M. Vasyliunas

There are few space physicists who have had as much impact on their respective areas of research as has Vytenis M. Vasyliunas. Born 35 years ago in Kaunas, Lithuania, he immigrated with his parents to the United States at an early age. He received an A.B. (cum laude) from Harvard University in 1962 and a Ph.D. from MIT in 1966. He held a Sloan Fellowship from 1971 to 1973.

Vasyliunas is held in awe by many of his colleagues, if only on the strength of his intellect. His knowledge of the literature in the active field of magnetospheric physics and in associated fields is both critical and encyclopedic. This is demonstrated in his publications and is most obvious in his critical reviews. In his reviews, talks, and review papers, he is able to draw many diverse elements together, pointing out hitherto unexpected similarities and differences and placing large blocks of the field into reasonable perspective. In addition, he has performed truly significant services to the AGU and the scientific community in the role of critic, both as a referee of papers submitted for publication and as an astute and penetrating instant analyst. His remarks have become his trademark at meetings on magnetospheric physics. For example, one author confided in me that he would pay to have his paper refereed by Vasyliunas. He said, 'Not only does he tell me how to fix up my paper and tie up all the loose ends, but he also outlines my next research project.' As an editor, I have seen many of Vasyliunas' referee reports; often they were better than the paper he was refereeing.

His research papers show an impressive range of versatility. For some of them he has helped design experiments, directed and performed data analysis, and interpreted the results. In other papers he shows that he is one of the few space physicists who can do pure theoretical research. In this sense, he represents the 'complete scientist' by demonstrating ability in all phases (both experimental and theoretical) of a scientific endeavor.

In his experimental research, he outlined the configuration and dynamical behavior of the Alfvén layer (the earthward side of the plasma sheet that extends across the geomagnetic tail). He also developed an associated mathematical model that describes the plasma response to magnetospheric convection, and he established a coupling of magnetospheric and ionospheric configurations in a variety of circumstances. In another paper, using nothing more than first principles, he established the conditions under which ionospheric currents must be three-dimensional and coupled to magnetospheric currents. This one result was so powerful (and so simple) that all subsequent work in the field has taken it into account. His most recent research has resulted in a review paper for *Reviews of Geophysics and Space Physics* that, in my opinion, will prove to be a classic. The topic concerns the fundamental process of magnetic merging, which is of importance to space physics, plasma physics, and astrophysics. Until now, the literature on the subject has been contradictory and confusing. His review paper sheds light and understanding. It will be appreciated and referenced for many years to come.

The choice of Vytenis Vasyliunas for the Macelwane Award is appropriate. The American Geophysical Union will someday be able to look back with smug pride at its early recognition of one of its most outstanding scientists.

Alexander J. Dessler
(Read by Robert L. Carovillano)

Acceptance and Response

Although it is sometimes said that a scientist is motivated by a disinterested search for knowledge, in our more candid moments we all realize that recognition by one's colleagues is at least as important. The Macelwane award, especially when accompanied by the very generous citation just presented by Bob Carovillano, is a high form of recognition indeed. Like all the other recipients, I am very pleased and deeply grateful; these feelings are tempered (although certainly not lessened) by the realization that every recognition implies a corresponding responsibility and that this high honor also raises high expectations, which God grant I may be able to fulfill.

A number of AGU awards over the years have been given in recognition of work in space physics (including tonight's Fleming medal), but this one is the first awarded to one who might be called a second-generation space physicist, whose career began within space physics as an already well-established field; the 'Van Allen belts' was a household phrase before I entered graduate school. This award is also a recognition that space physics—like all facets of man's attempt to understand the world, whichever frontier of knowledge one is seeking to advance—provides challenging problems, exciting opportunities for a deeper understanding, and ample scope for scientific talent; this recognition is especially significant as it, perhaps, is not universally shared.

A scientist does not work in isolation and, like all the other recipients, I am deeply thankful to my teachers and my colleagues, without whom my work would not have been possible. I regret I cannot here acknowledge each of them by name, because of limited time (and fear of accidentally overlooking someone). One name, however, I must mention: Herbert Bridge, who granted me unrestricted use of his satellite observations, allowed me full freedom to pursue the theoretical efforts that grew out of the data analysis (even when these led far afield), and provided extensive occasions for interacting with the scientific community. With rare self-effacement and with not always adequate appreciation from outside and support from inside, Herb created a unique environment in which, to paraphrase the terms of the award, significant contributions to the geophysical sciences could be made at the earliest possible age.

With a sense of pleasure at the honor and awareness of the responsibility, with pride for being part of a vital and exciting field of physics, and with deep thanks to the American Geophysical Union and to all my colleagues and friends, I accept the Macelwane award.

Vytenis M. Vasyliunas

Fellows Elected 1975

Tanya M. Atwater
C. Wayne Burnham
Richard A. Craig
G. Brent Dalrymple
Robert L. Fleishcher
Hiroo Kanamori
Xavier Le Pichon
Thomas B. McCord
P. Buford Price
Joseph L. Reid
Karl K. Turekian
Seiya Uyeda
George Veronis
Peter J. Wyllie