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Dick McCormack
Headquarters, Washington, D.C.
(Phone: 202/755-4321)

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Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/344-5565)

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NASA SELECTS SCIENTIFIC INVESTIGATIONS FOR EARTH DYNAMICS STUDIES

NASA has selected 56 scientific investigators to study the Earth's tectonic plate movement, crustal deformation and rotational dynamics with data acquired by space techniques.

The data are obtained primarily as part of NASA's Crustal Dynamics Project formed by NASA in 1979 to apply space methods and technology to improve understanding of the dynamic behavior of the Earth which, in turn, should lead to a better understanding of earthquake mechanisms and motions of the Earth's crust. The project is managed by NASA's Goddard Space Flight Center at Greenbelt, Md., with participation by the Jet Propulsion Laboratory in Pasadena, Calif.

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Using precise geodetic data obtained with laser ranging and radio interferometry, the investigators will study regional crustal deformation in California, Alaska and other regions of high earthquake activity; the current-day relative motion between the Earth's major tectonic plates; the internal stability of the North American and Pacific plates; and variations in the Earth's rotation rate and position of its polar axis.

Forty-two domestic investigators are affiliated with U.S. universities, governmental agencies, or private concerns; 14 foreign investigators are from France, West Germany, the Netherlands, Switzerland, Spain, Sweden, Australia, New Zealand, Venezuela and Canada. Thirteen of the investigations, involving studies in Europe, Mexico and the Caribbean, have been tentatively selected pending development of joint measurement programs and agreements with the countries involved.

Two techniques have been developed to make precise measurements between two points separated by large distances (thousands of kilometers). The first involves laser ranging to artificial satellites and to the Moon.

The Lageos satellite, launched by NASA on May 4, 1976, into a nearly circular orbit at an altitude of 5,800 kilometers (3,600 miles), is a sphere whose surface is covered with 426 optical cube corner reflectors which reflect back to the source any incident optical signal. By accurately and repeatedly measuring the time for a laser pulse to travel to the satellite and return, the position of the ground laser can be determined with high accuracy.

When similar measurements are made from a second station (which can be located on a different continent), the distance between the two stations can be determined with a precision of about 5 centimeters (2 inches).

Lunar reflectors were implanted by the crews of Apollo 14, 15 and 16, and by two Soviet unmanned Luna missions. In addition to studies of the Earth, lunar laser ranging has provided valuable information on the dynamic motion of the Moon and its orbit, and has been used to study theories of general relativity.

The second technique, called Very Long Baseline Interferometry, involves the analysis of radio signals emitted by quasars and other celestial objects. These emissions are received and recorded on magnetic tape by two or more radio telescopes separated by large distances. These signals are subsequently compared to determine the difference in the time at which the signals reached each telescope, and the time differences are analyzed to determine the precise distance between each of the stations. Currently the precision of this technique is on the order of 3 cm (1.4 in.).

By making repeated measurements over a period of years using both techniques, crustal motions as small as 1 cm per year can be determined. Current knowledge of the relative motions of the tectonic plates is based on paleomagnetic data and other information, and is averaged over the past several million years of geologic time. These averaged rates are estimated to be between 1 and 20 cm/year.

Using laser ranging and Very Long Baseline Interferometry, these movements can be directly measured for the first time, and tectonic models can be revised to reflect contemporary plate motion.

In California, Alaska and other regions of high earthquake activity, the driving forces of plate tectonics cause a buildup of crustal strain near plate boundaries. When the resulting stress exceeds the strength of the underlying materials, the stress is released in the form of earthquakes or slow creep. A major objective of the Crustal Dynamics Project is to measure and analyze regional deformation and strain accumulation along major plate boundaries such as the San Andreas Fault in California, which separates the North American Plate from the Pacific Plate. This will help us to understand the basic mechanisms leading to earthquakes, and eventually to the development of a reliable earthquake prediction model.

In order to measure the accumulation of crustal strain over an active tectonic region, measurements must be made at many sites. NASA has developed highly mobile systems using both laser ranging and Very Long Baseline Interferometry technology which can easily relocate from one site to another within a matter of days. Mobile systems using Very Long Baseline Interferometry techniques have been developed at the Jet Propulsion Laboratory and mobile laser systems have been developed at Goddard Space Flight Center and the University of Texas.

These systems are now being deployed in the western United States and the data obtained will be made available to the selected investigators. Over the life of the Crustal Dynamics Project, which will extend through 1986, measurements are expected to be made between fixed and mobile stations in the United States, Canada, Mexico, South America, the Caribbean, Australia, New Zealand and Europe.

The analysis and publication of the results of the investigations are generally planned for a period of between two and five years, depending on the nature of the investigation, and all are expected to be completed by the end of 1986.

All principal investigators will become part of the Crustal Dynamics Working Group, which will meet twice a year during the course of the investigations to discuss progress and/or problem areas. The initial meeting is scheduled for Sept. 1-3 at Goddard Space Flight Center.

The selected crustal dynamics investigations and their principal investigators are as follows (those tentatively selected are indicated by a asterisk):

Regional Deformation (23)

SAFE II - The San Andreas Fault Experiment -- Christopher Scholz, Lamont-Doherty Geological Observatory, Palisades, N.Y.

Interpretation of Crustal Deformation Data in Southern California -- John B. Rundle, Sandia National Laboratories, Albuquerque, N.M.

*Deformation of the Northern Caribbean Plate Margin -- Carl Bowin, Woods Hole Oceanographic Institution, Woods Hole, Mass.

Finite Element Modeling of Crustal Strain -- Gregory A. Lyzenga, Jet Propulsion Laboratory, Pasadena, Calif.

Interpretation of Crustal Dynamics Data in Terms of Plate Motions and Regional Deformations Near Plate Boundaries -- Sean C. Solomon, Massachusetts Institute of Technology, Cambridge.

Tectonic Deformation in Southern California -- David D. Jackson, University of California, Los Angeles.

A Plan for VLBI Measurements in Alaska to Determine Plate Convergence, Intraplate Deformation and Possible Coseismic Displacements -- Tracy Johnson, Lamont-Doherty Geological Observatory, Palisades, N.Y.

Measurements of Crustal Motion in the United States Using Laser Tracking Observations -- Ronald Kolenkiewicz, Goddard Space Flight Center, Greenbelt, Md.

Correlation of Data on Strain Accumulation Adjacent to the San Andreas Fault With Available Models -- Donald L. Turcotte, Cornell University, Ithaca, N.Y.

*Displacement, Strain and Relative Plate Motion in the Africa/Arabia/Anatolia/Eurasia Plate System: A Synthesis of Landsat and Ground Studies With VLBI Data -- John F. Dewey, State University of New York, Albany.

*Neotectonics of the Northern Caribbean Plate Boundary Zone: A Synthesis of VLBI and Laser Ranging Data With Neotectonic Field Studies in Jamaica and the Dominican Republic -- Kevin Burke, State University of New York, Albany.

*Conduct Crustal Dynamics Investigations Along the Eurasian-African Plate Boundary -- Peter Wilson, Munich Technical University, Munich, West Germany.

NZ/NASA Cooperative Crustal Deformation Programme -- R. I. Walcott, Department of Industrial and Scientific Research, Wellington, New Zealand.

*Plate Motion and Tectonic Deformation in Southern Caribbean - Northern Venezuela Using VLBI Data -- Omar J. Perez, Venezuelan Foundation for Seismological Research, Caracas, Venezuela.

*Crustal Dynamics of the Eastern Mediterranean -- Max Wyss, University of Colorado, Boulder.

*A Plan for VLBI Measurements in the Caribbean to Determine Relative Plate Motions and Possible Intraplate Deformation -- Roger Bilham, Lamont-Doherty Geological Observatory, Palisades, N.Y.

*Working Group of European Geo-Scientists for Establishment of Networks for Earthquake Research -- Hans Gert Kahle, Institute for Geodesy and Photogrammetry, Zurich, Switzerland.

Testing of Hypotheses in Crustal Dynamics Using VLBI and SLR Data From California -- G. Peter Bird, University of California, Los Angeles.

Modeling of Tectonophysical Distortion From Measurement of Long-Baseline Geodetic Data and Other Geophysical Parameters -- James H. Whitcomb, University of Colorado, Boulder.

*High-Precision Gravity Network in the Aegean Region -- Wolfgang Torge, University of Hannover, Hannover, West Germany.

North American Plate Deformation in Canada -- Anthony Lambert, Department of Energy, Mines and Resources, Ottawa, Canada.

*Tectonic, Seismic and Geodetic Studies of the Gulf and Peninsula of California -- Gordon Ness, Western Oregon State College, Monmouth, Ore.

*Strategies for Satellite Laser Ranging to Investigate Crustal Movements as Related in Particular to the Eurasian Lithospheric Plate -- Leendert Aardoom, Delft University of Technology, Delft, The Netherlands.

Plate Deformation and Plate Motion (13)

Determination of the Large-Scale Crustal Motion of Australia by Satellite Laser Ranging - Artur Stolz, University of New South Wales, Kensington, Australia.

Intraplate Deformation, Stress in the Lithosphere, and the Driving Mechanism for Plate Motions -- Bradford H. Hager, California Institute of Technology, Pasadena.

Plate Motions and Deformations From Geologic and Geodetic Data -- J. Bernard Minster, Systems, Science and Software, La Jolla, Calif.

Plate Motions and Deformations From Geologic and Geodetic Data -- Thomas H. Jordan, Scripps Institute of Oceanography, La Jolla, Calif.

VLBI Determination and Interpretation of Relative Motions Within a Network of Sites in North America and Europe -- Irwin I. Shapiro, Massachusetts Institute of Technology, Cambridge.

Determination of the Relative Horizontal and Vertical Motions of Stations in the Laser Tracking Network -- David E. Smith, Goddard Space Flight Center, Greenbelt, Md.

Studies of Continental Deformation, Plate Motion and Polar Motion, Using Geodetic Data From Space Techniques -- Richard J. O'Connell, Harvard University, Cambridge, Mass.

Space Based Measurements of Crustal Deformation in the U.S.: Interpretation in Light of Other Geodetic, Geophysical and Geological Information -- Jack E. Oliver, Cornell University, Ithaca, N.Y.

SLR/VLBI Investigations of Regional Lithospheric Deformation and Contemporary Plate Motion -- Seth Stein, Northwestern University, Evanston, Ill.

*Contribution of GRGS to Crustal Dynamics by VLBI Techniques -- C. Boucher, National Institute of Geography, Saint Monde, France.

Studies of Polar Motion, Earth Rotation and Plate Motions -- W. Jason Morgan, Princeton University, Princeton, N.J.

*A Study of Geophysical Mechanisms of Recent Crustal Movements Affecting Scandinavian Tied Space Geodetic Baselines and the Interpretation of Results -- Allen Joel Anderson, University of Uppsala, Sweden.

A Program on Crustal Dynamics and Earthquake Research -- Alfonso Lopez Arroyo, National Institute of Geography, Madrid, Spain.

Polar Motion and Earth Rotation (7)

Atmospheric Excitation of Changes in Earth Rotation and Polar Motion -- Richard D. Rosen, Environmental Research and Technology, Inc., Concord, Mass.

Crustal Dynamics and Earthquake Research -- Peter J. Shelus, University of Texas, Austin.

Analysis of Variable Earth Rotation for Geophysical Sources -- Charles F. Yoder, Jet Propulsion Laboratory, Pasadena, Calif.

Lunar Laser Ranging Data Analysis and Modeling -- James G. Williams, Jet Propulsion Laboratory, Pasadena, Calif.

Geophysical Interpretation of Spatial Geodetic Data -- B. Lago, Department of Research for Space Geodesy, Toulouse, France.

Study of Earth-Moon System by Lunar Laser Data Analysis -- Odile Calame, Department of Research for Space Geodesy, Grasse, France.

Contribution of GRGS to Crustal Dynamics Program Based on Satellite Laser Ranging -- Francois Barlier, Department of Research for Space Geodesy, Grasse, France.

Technique Development (13)

Towards a Statistical Understanding of Tectonic Motions - Analysis of Crustal Dynamics Observations -- Duncan C. Agnew, Univeristy of California at San Diego, La Jolla.

Study of the Use of Laser Ranging and VLBI Data in the Routine Rapid Determination of Earth Orientation Parameters -- Dennis D. McCarthy, U.S. Naval Observatory, Washington, D.C.

Empirical Strain Modeling and Verification of Space Geodetic Information -- John L. Fanselow, Jet Propulsion Laboratory, Pasadena, Calif.

Measurement of a Baseline to High Precision Using VLBI -- Kenneth J. Johnston, Naval Research Laboratory, Washington, D.C.

Analysis of Lunar Laser Ranging Data for Earth Dynamics -- Irwin I. Shapiro, Massachusetts Institute of Technology, Cambridge.

Development of Techniques to Reduce the Error in VLBI Determinations of Transcontinental and Intercontinental Baseline Lengths to Less Than One Centimeter -- Alan E.E. Rogers, Haystack Observatory, Westford, Mass.

Satellite Laser Ranging to Crustal Dynamics -- Byron D. Tapley, University of Texas, Austin.

Improving the VLBI Reference Frame -- David B. Shaffer, Phoenix Corp., McLean, Va.

Center of Mass Laser Tracking Station Coordinate Determination and Lithospheric Plate Motion Investigation -- James G. Marsh, Goddard Space Flight Center, Greenbelt, Md.

Gravity Model Improvement Using Laser Data -- Francis J. Lerch, Goddard Space Flight Center, Greenbelt, Md.

Determination of Worldwide Tectonic Plate Motions and Large Scale Intra-Plate Distortions -- Peter L. Bender, National Bureau of Standards, Boulder, Colo.

Satellite Laser and VLBI Technique Validation Through Intercomparison of Vector Baselines -- James W. Ryan, Goddard Space Flight Center, Greenbelt, Md.

Measurement of Contemporary Tectonic Plate Motions by Very Long Baseline Interferometry -- Thomas A. Clark, Goddard Space Flight Center, Greenbelt, Md.

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