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Present Status and Future Prospects for NASA's Program in Geodynamics

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Since 1972 NASA has been developing systems for precise determination of polar motion, earth rotation, and position on the earth's surface. The two observational methods are laser ranging to the moon and to artificial satellites, and very long baseline microwave interferometry (VLBI).

Lunar laser ranging has been done at the University of Texas' McDonald Observatory at Fort Davis, Texas, since 1969. A second lunar laser observatory is under development by the University of Hawaii on Haleakala, Maui (Hawaii). Similar observatories are also being constructed in Japan, Australia, and in Europe. Satellite laser ranging facilities capable of ranging to Lageos (6000 km altitude) are in operation at Haleakala, several sites in Europe, and at facilities operated by the Smithsonian Astrophysical Observatory (Mt. Hopkins, Arizona; Natal, Brazil; Arequipa, Peru; and Canberra, Australia).

Several radio telescopes are now equipped for geodetic VLBI observations: Haystack Observatory (Massachusetts), Owens Valley Radio Observatory (California), Onsala (Sweden), Bonn (West Germany), the Deep Space Network Station at Goldstone (California), and the Harvard antenna at Fort Davis (Texas). The National Geodetic Survey plans to establish a network of three dedicated VLBI observatories at Westford (Massachusetts), Richmond (Florida), and the Fort Davis antenna, in order to measure polar motion and earth rotation.

The range accuracy now being attained routinely at McDonald Observatory is about 6 cm. Repeated measurements of the baseline length between Haystack and OVRO agree to within 4 cm.

NASA has constructed eight mobile laser ranging facilities (Moblas) some of which have been used for the San Andreas Fault Experiment since 1972, in which the distances between two sites in California have been measured every two years. Another transportable laser ranging facility is being developed by the University of Texas at Austin; this is a small and highly mobile station, to be completed in 1980, that can move from site to site very rapidly and which should achieve an accuracy of better than 3 cm.

Two mobile VLBI facilities have been constructed by the Jet Propulsion Laboratory, one with a 9 m antenna and one with a 4 m antenna. The larger of these (ARIES) has been used to measure position differences between several sites in California and one of the fixed stations (Goldstone and OVRO).

A plan for a NASA geodynamics program has been written, and copies may be obtained on request from the address above. The document describes the activities NASA intends to carry out to apply space technology to research in earth dynamics. These activities may be categorized as being global, regional, and local in nature. On a global level, NASA will cooperate with other Federal agencies and with scientists in other countries to establish observatories for measurement of polar motion and earth rotation, to establish a global reference frame, and to serve as base stations for the mobile stations.

On a smaller scale, mobile stations will be used to establish a reference frame for the North American, Pacific, and Australia plates. A major part of the program will be to operate mobile stations in tectonically active regions in order to observe crustal movements related to tectonic processes. Initially the program will concentrate on Western North America, where a network of about thirty sites between the Colorado Plateau and the Pacific will be occupied by mobile stations about three times a year. The sites will be about 50 km apart near the San Andreas Fault, and up to 500 km apart toward the east.

Later, beginning in about 1982, the mobile stations will begin to operate in other active areas. Promising candidates are Central and South America, New Zealand, the Samoa-Fiji-New Caledonia area, and Japan. NASA scientists are involved in informal discussions with scientists in these areas, and it is hoped that agreements on cooperative programs will be developed within the next few years. The European Space Agency is formulating plans for a geodynamics program, and it is anticipated that a program similar to that under development by NASA will take shape in the near future.

The problem of measuring vertical and horizontal movements on a local scale (less than 50 km, say) is an important one. It appears that space methods may be capable of augmenting ground-based methods at this scale, and may have advantages in terms of economy and rapidity of coverage. Candidate methods include spaceborne laser ranging to retroreflectors on the ground, and the use of radio sources in artificial satellites to measure position differences in several ways. Specifically, the possibility appears promising to make use of the Global Positioning System satellites for this purpose. NASA intends to support studies of several systems for measuring local crustal movements.

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