

Statement of
Dr. Sean C. Solomon
Director, Department of Terrestrial Magnetism
Carnegie Institution of Washington

before the Committee on Science
The U.S. House of Representatives

Hearing on “NASA’s Earth Science Program”

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Thank you, Mr. Chairman, Ranking Minority Member, and members of the House Science Committee. I am pleased to join you today to comment on NASA’s programs in Earth science.

By way of introduction, I am both an Earth scientist and a planetary scientist. I am the Director of the Department of Terrestrial Magnetism at the Carnegie Institution of Washington, a former President of the American Geophysical Union — with more than 40,000 members the world’s largest professional society in the Earth sciences, and the Principal Investigator for one of NASA’s missions in solar system exploration.

First, let me begin by affirming my conviction that NASA has a continuing, strong role to play in the study of our planet. As the lead federal agency for technical innovation in space, with a clear charter for advancing basic knowledge of how this planet operates and for applying that knowledge to address problems of substantial societal importance, NASA can contribute to an understanding of the Earth and its workings in unique and fundamental ways. As this committee has expressed on many occasions, NASA’s responsibilities in the Earth sciences are worthy of sustained national support.

Second, I applaud the Earth science community for undertaking a decadal survey of Earth science and applications from space. This survey, co-chaired by Dr. Moore and operated under the aegis of the National Academy of Sciences and the National Research Council, is long overdue. Like the decadal surveys that the astronomy community has produced for the last four decades and the decadal survey that the solar system exploration community published in 2002, this decadal survey for Earth science and applications from space will provide a rationale for the most important missions and programs that NASA should undertake in the coming decade, established on the basis of sufficient community input and set out with sufficient clarity so that the program is seen by all as both achievable in scope and compelling in vision.

In 2000 NASA’s Associate Administrator for what was then the Office of Earth Science asked me to chair a working group “to guide the science community in the development of a recommended long-term vision and strategy from solid-Earth science at NASA.” Over a period

of two years that Solid Earth Science Working Group gathered advice from the community, and in 2002 we published our recommendations for a NASA program in solid-Earth science and applications for the coming quarter century. That effort served as a microcosm for the ongoing Earth science decadal survey and indeed for the challenge that NASA now faces as it integrates the most important objectives across all of its programs. Today I'd like to summarize the criteria that our working group used to prepare its strategy, the most important questions that our group felt should guide NASA's programs, and the most critical mission opportunities that our group recommended NASA should pursue to address those questions.

The surface of the Earth is where we live. Though largely solid, the interior of the Earth is far from static. The Earth's internal motions — and interactions of the solid Earth with the oceans, hydrosphere, and atmosphere — continually change the surface of our planet. Some of those changes progress at rates that seem nearly imperceptible over human lifetimes, but others concentrate catastrophically during earthquakes, volcanic eruptions, landslides, floods, tsunamis, and other natural disasters. Space offers a particularly special vantage point from which to study these phenomena, because of the broad, synoptic view and the global coverage afforded. Many of the workings of the solid Earth are linked by plate tectonics — the theory that the Earth's outer layer is divided into nearly rigid plates that are in relative motion and interact primarily at their boundaries. NASA's solid Earth program made a critical contribution to this theory, when space geodetic techniques provided the first direct measurements of plate motions previously inferred only from the geological record. The frontier research areas now are in understanding the details of deformation and volcanism near plate boundaries and the interaction of the solid Earth with the rest of the Earth system.

The Solid Earth Science Working Group utilized four criteria for selecting the most important questions in solid Earth science that could be addressed by NASA. First, the question should be of fundamental scientific importance. Second, the question should have strong implications for society. Third, the question should be amenable to substantial progress through new observations. And fourth, there should be unique contributions that NASA can make toward providing answers. These are quite general criteria that can be applied equally well across other NASA programs.

On the basis of these criteria, the working group identified six grand challenges, questions of the highest priority for NASA's solid Earth science program over the next 25 years:

1. What is the nature of deformation at plate boundaries, and what are the implications for earthquake hazards?
2. How do tectonics and climate interact to shape the Earth's surface and create natural hazards?
3. What are the interactions among ice masses, oceans, and the solid Earth and their implications for sea-level change?
4. How do magmatic systems evolve, and under what conditions do volcanoes erupt?

5. What are the dynamics of the mantle and crust, and how does the Earth's surface respond?
6. What are the dynamics of the Earth's magnetic field and its interactions with the Earth system?

Addressing these challenges involves leveraging partnerships with other NASA programs, with other federal agencies, and with international space agencies. Nonetheless, there are specific technological capabilities and orbital opportunities that only NASA can provide. The Solid Earth Science Working Group identified several observational strategies — each combining spaceborne and ground measurements with technological advances — where NASA should provide leadership: surface deformation, high-resolution measurements of topography and topographic change, variability in Earth's gravity and magnetic fields, imaging spectroscopy of Earth's changing surface, space geodetic networks and the International Terrestrial Reference Frame, and promising new techniques.

In the next several years, the highest-priority new mission for the solid Earth sciences is a satellite dedicated to Interferometric Synthetic Aperture Radar (InSAR). Such a mission is technically feasible today and addresses five of the six grand scientific challenges for the solid Earth. Operating at a frequency that can penetrate vegetative cover (L-band) and that has weekly access to any land area, such an InSAR system could measure surface displacements at the 1 mm/yr level over 50-km horizontal extents. InSAR satellites flown by European and Canadian space agencies have revealed the enormous potential of such a technology, but at radar frequencies and repeat viewing rates that are not optimum for understanding solid Earth phenomena. The recommended mission would open the globe to new observations of ongoing surface movements in major earthquake zones, at active volcanic centers, on the Earth's major ice sheets, along coastal zones, and in areas susceptible to floods and landslides. Such observations are likely to reveal diagnostics of the governing phenomena and can provide a regionally complete basis for disaster mitigation and response.

A NASA-led InSAR satellite is a critical element of the multi-agency EarthScope project, whose other elements — supported by the National Science Foundation — include seismometers, GPS sensors, strainmeters and a San Andreas Fault drilling project that together will address the nature of deformation within western North America as well as the structure and governing geological processes of the North American continent. A NASA InSAR satellite has also been requested by the U. S. Geological Survey to assist that agency with their ongoing assessment of seismic hazards and their mitigation within the United States.

The recommendations of the Solid Earth Science Working Group, of course, cover only one component of NASA's Earth science programs. The NRC decadal survey and NASA's own roadmapping activities, both currently underway, promise to provide a broader framework of recommended programs within which the component addressing the solid Earth and its interactions with the other elements of the Earth system will hold a natural place.

NASA is an agency that is carrying out a truly impressive range of human and robotic missions designed to explore our space environment, our planetary neighbors, and the entire

cosmos. It is important as NASA carries out its many missions of exploration that we do not lose sight of the special role that only NASA can play in unraveling the mysteries of our own planet. For the foreseeable future, Earth is our only home, and we owe it to our children and theirs to understand how to live here to the betterment of all.

Biographical Background

Sean C. Solomon is the Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, a position he has held since 1992. He received his B.S. from Caltech in 1966 and his Ph.D. from MIT in 1971, after which he was a Professor of Geophysics at MIT for more than 20 years.

A seismologist, marine geophysicist, and planetary scientist, Solomon has worked on a wide range of problems in earthquake seismology, geodynamics, and the nature and evolution of the terrestrial planets. He served on science teams for NASA's Magellan mission to Venus and Mars Global Surveyor mission, and he is the Principal Investigator for NASA's MESSENGER mission now en route to orbit the planet Mercury.

From 2000 to 2002 Solomon chaired NASA's Solid Earth Science Working Group, which developed a long-term vision and strategy for solid-Earth science at NASA. Solomon earlier served on NASA's Space and Earth Science Advisory Committee, Solar System Exploration Subcommittee, and Earth System Science and Applications Advisory Committee. He also sat on the National Research Council's Space Science Board and chaired its Committee on Earth Sciences. He currently serves on NASA's Strategic Roadmap Committee for Earth Science and Applications from Space.

Solomon is a member of the National Academy of Sciences, a Fellow of the American Academy of Arts and Sciences, and a past President of the American Geophysical Union. A former Alfred P. Sloan Fellow and John Simon Guggenheim Fellow, he received the Arthur L. Day Prize from the National Academy of Sciences, the G. K. Gilbert Award from the Geological Society of America, the Harry H. Hess Medal from the American Geophysical Union, and NASA's Public Service Medal.