Studying Silicate-Ice Bodies in the Solar System

Evolution of Small Silicate-Ice Bodies in the Solar System; Winthrop, Washington, 6–8 August 2010

PAGE 66

Interest is growing in a class of small bodies in the solar system, some of which are believed to be the building blocks of the terrestrial planets. These include Ceres, Vesta, Pallas, the icy satellites, and some solid objects farther out in the solar system. Many of these objects appear, from their bulk density and shape, to be composed of a mixture of water and silicates, with short- and long-lived radioisotopes as energy sources. These are the ingredients for dynamic thermal evolution, including differentiation and mineral and carbon chemistry, and the potential for internal liquid water layers even today.

Evidence for this comes from at least one family of asteroids, the Themis group, which may be pieces of a differentiated water- and organic-rich protoplanet. The Themis family is being studied to reveal a profile of its parent body. Also, the NASA Dawn spacecraft (C. T. Russell et al., *Planet. Space Sci., 52*(5-6), 465–489, 2004) is on its way to orbit Vesta in 2011 and Ceres in 2015. These objects and the Dawn mission stimulated a workshop series, initiated in 2006, to assess the evolutionary history of these objects, with the fourth workshop held at the Bear Fight Institute in Washington State. The major physical and chemical processes involved were covered at the workshop. The workshop focused on the development of a composition model for Ceres's surface to help plan the Dawn observations. The approach built on recent publications of thermodynamic models for Ceres (T. B. McCord and C. Sotin, *J. Geophys. Res., 110,* E05009, doi:10.1029/2004JE002244, 2005; J. C. Castillo-Rogez and T. B. McCord, *Icarus, 205*(2), 443–459, 2010) and involved representatives from a variety of fields: cosmochemistry, geophysics, geology, remote sensing, and material properties.

One research area identified at the workshop is how chemistry drives thermal evolution, for example, by affecting the thermophysical properties of the accreted icy and rocky materials, and how the geochemical environments change with evolution. Relevant processes include mineralization and heating, resulting from the interaction of liquid water and silicate grains following differentiation, and the long-term preservation of liquid layers. Heat from long-lived radioisotopes eventually drives inner core dehydration, which affects the entire object, especially through energy exchanges. Late-stage hydrothermal circulation as the core is cooling may further promote hydrogeochemistry. Carbon and perhaps ammonia, if found to be present at Ceres, would lead to more possibilities for interesting chemistry, perhaps as a base for biology. Participants agreed that important observations for Dawn to make include the surface compositions and signatures of endogenic activity. These observations can provide information about Ceres's present interior.

There is growing observational and theoretical evidence confirming the thermal or chemical activity within these silicate-ice objects, and this class of objects in the solar system is gaining recognition for its habitability potential. Thus, the Dawn mission, NASA's New Horizons mission to Pluto, and subsequent missions have the potential for major discoveries.

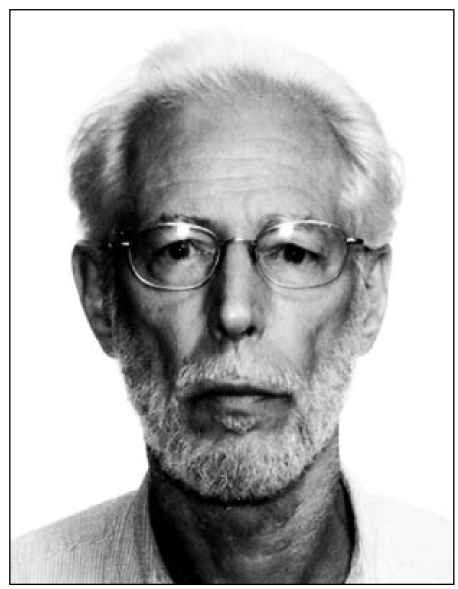
—THOMAS B. MCCORD, Bear Fight Institute, Winthrop, Wash.; E-mail: tmccord@bearfightinstitute.com; and JULIE C. CASTILLO-ROGEZ, Jet Propulsion Laboratory, California Institute of Technology, Pasadena

ABOUT AGU

Paul F. Hoffman Receives 2010 Walter H. Bucher Medal

Paul F. Hoffman was awarded the 2010 Walter H. Bucher Medal at the AGU Fall Meeting Honors Ceremony, held on 15 December 2010 in San Francisco, Calif. The medal is for "original contributions to the basic knowledge of the crust and lithosphere."

PAGE 67



Paul F. Hoffman

Citation

Over the past 5 decades, Paul Felix Hoffman has profoundly changed our understanding of the origin and evolution of the continental crust and lithosphere by field mapping, regional synthesis and interpretation, and relentless hypothesis testing.

Paul has spent 48 seasons in the field and 25 of those in the Canadian Shield. For his Ph.D. studies at Johns Hopkins University and his early years at the Geological Survey of Canada (GSC), Paul worked on the spectacularly exposed rocks in the east arm of Great Slave Lake. Subsequently, he examined a transect across the Paleoproterozoic Coronation geosyncline and argued in several influential papers that plate tectonics was active at that time and remarkably similar to today's regime. These papers are even more remarkable when we consider that it was at a time when modern-day plate tectonics had still not been widely accepted.

This work was followed by a decade of understanding the history of the Coronation geosyncline, later named Wopmay orogen. His earlier synthesis, based on reconnaissance, made a number of testable predictions, and Paul set out to falsify his own ideas. Paul recognized that the zonation of the belt could be interpreted in terms of a model involving rifting, passive margin subsidence, arc magmatism, and collision. He led teams of students, coworkers, and colleagues during an intense decade of investigation. When he published his first Wopmay synthesis, in 1980, Precambrian geology was mired in nonactualistic models for crustal evolution, with few based on detailed mapping and regional synthesis.

The lessons learned in Wopmay orogen and the recognition of the power of synthesis led Paul to expand his approach to the Precambrian of Laurentia and the history of supercontinents; his approach was transformative. Hoffman's iconic map of Laurentia made it clear that the anastomosing Proterozoic orogenic belts between Archean cratons recorded the consumption of oceanic lithosphere, the collision of continental fragments, and the stabilization of large cratons underlain by cold, buoyant lithospheric mantle. The recognition of short-lived collisional events that produced a vast orogenic collage was a radical departure from crustal reworking and long-lived