Washington University in St. Louis
ARTS & SCIENCES

The Faculty of the Department of

# Earth & Planetary Sciences

## Ray Arvidson, *James S. McDonnell Distinguished University Professor, Planetary Geologist*

Ray Arvidson is a planetary geologist who focuses on use of sedimentary rock records and current surface processes to understand past and current environmental conditions on the terrestrial planets. He currently focuses on use of landed and orbital measurements to characterize present and past conditions on Mars, studying the role of climate and water. Analog studies of key sites on Earth are also examined to better understand planetary processes. Field sites are or have included hydrothermally altered cinder cones on Mauna Kea, Hawaii, steam vents in Kilauea, Hawaii, and the evaporative acid-sulfate fluvial system in Rio Tinto, Spain.

## Alex Bradley, *Assistant Professor, Microbial Geochemist*

Alex Bradley is a biogeochemist who uses the chemical traces of life to investigate the coevolution of life and the Earth. He is primarily an organic geochemist, and his laboratory analyzes the structures and isotopic compositions of geologically stable organic compounds. His research is focused on understanding the relationships among organisms, environments, and the geochemical traces they produce. Current research projects involve understanding carbon cycling in hydrothermal systems, performing laboratory experiments to better understand controls on isotope fractionation, and using genetic and physiological tools to understand the nature of geochemical biomarkers from plants and microbes.

## Jeff Catalano, *Assistant Professor, Environmental Geochemist/Mineralogist*

Jeff Catalano studies the geochemistry and mineralogy of terrestrial and planetary aquatic systems, with a focus on processes that control the distribution and cycling of major and trace elements. He is currently interested in biogeochemical element cycling and contaminant fate in terrestrial environments and mineral formation and alteration on Mars. These studies integrate laboratory-based analytical and microscopy tools, synchrotron-based X-ray spectroscopic and scattering methods, and geochemical modeling.

## Bob Criss, *Professor, Geochemist*

Bob Criss and his associates use stable isotope techniques and field measurements to study rivers, springs, and floods. Criss also investigates hydrothermal systems, ore deposits, heat flow, and caves, and develops theoretical equations for hydrologic and isotopic phenomena.

## Bob Dymek, *Professor, Petrologist*

Bob Dymek is a petrologist, and geologist, who utilizes field, chemical, and phase petrology in the study of igneous and metamorphic rocks. His research focuses on the mineralogy, chemistry, and origin of Precambrian rocks, especially anorthosites of various types.

http://eps.wustl.edu

## Bruce Fegley, *Professor, Planetary Scientist*

Bruce Fegley's research involves experimental and theoretical studies of chemical processes in the early solar system, on planetary surfaces, and in planetary atmospheres. The theoretical study of the chemistry of exoplanets and brown dwarfs is an exciting research area in Professor Fegley's group. He is a principal investigator in NASA and NSF research programs, the author of over 130 scientific papers, and three books including "*Practical Chemical Thermodynamics for Geoscientists*", "*Chemistry of the Solar System*" (coauthored with K. Lodders), and "*The Planetary Scientist's Companion*" (coauthored with K. Lodders).

## David Fike, *Assistant Professor, Isotope Geochemist*

David Fike measures the stable isotopes of carbon, sulfur, and nitrogen to better understand modern biogeochemistry, particularly the relationship between microbial ecology/activity and the generation of geochemical profiles that can be preserved in the rock record. His research includes the analysis of the C-S-N isotopic compositions of ancient sedimentary rocks to reconstruct the evolution of biogeochemical cycling over Earth history, particularly with regard to the impact of the oxygenation of the surface environment and the first appearance of animals (ca. 635 - 540 million years ago). Current research involves fieldwork in Oman, Namibia, Australia, and across the US and Canada. He is also interested in applying the same kinds of isotopic techniques to query the environmental history of Mars and other solar system bodies.

## Brad Jolliff, *Scott Rudolph Professor of Earth and Planetary Sciences, Petrologist*

Brad Jolliff studies planetary geology, geochemistry, mineralogy, and petrology. He uses planetary sample analysis, remote and in-situ sensing, and laboratory and field studies of terrestrial analogs to understand planetary processes. His focus is on the distribution of rocks and minerals on the Moon and Mars, and their geologic histories. He uses microbeam analytical methods coupled with geochemical analysis to determine mineralogy and chemistry. Mission involvement includes the Mars Exploration Rovers (Opportunity) and the Lunar Reconnaissance Orbiter Cameras (LROC).

## William McKinnon, *Professor, Planetary Geophysicist*

William McKinnon and his group focus their research on the outer solar system, particularly the major icy satellites of the giant planets, such as volcanic Io, oceanic Europa, and magnetic Ganymede, and dwarf planets in the Kuiper Belt such as Pluto. It is an extraordinarily rich arena in which to recapitulate all of geology and geophysics, but from a fresh perspective. Their research addresses internal structure, origin and evolution, tectonism and volcanism, impact mechanics and cratering history, and the potential for life. The geology and evolution of the satellites of Saturn have been a recent focus, and the New Horizon's encounter with the Pluto system is just around the corner (2015).

## Frederic Moynier, *Assistant Professor, Isotope Cosmochemist*

Frederic Moynier uses the isotopic compositions of terrestrial, lunar and meteoritic materials to understand 1) the chronology of the first million years of the Solar System, 2) the physical and chemical processes which have modified these materials, and 3) the nucleosynthesis and the stellar environments at the birth of our Solar System. To reach this goal, he uses high precision mass spectrometry associated with chemical purifications in an ultra-clean chemistry lab.

## Jill Pasteris, *Professor, Applied Mineralogist*

Jill Pasteris and her collaborators apply such techniques as Raman microprobe spectroscopy, electron microprobe analysis, atomic force microscopy, and electron microscopy (SEM and TEM) to questions of biomineralization. Her present work centers on biologically formed apatite in teeth and bones, which she studies in collaboration with orthopaedic researchers, engineers, synthetic chemists, and X-ray crystallographers. Some on-going projects involve investigation of the effects of carbonate substitution in synthetic analogs to bone mineral and chemical and biomechanical studies of the most highly mineralized natural bone, which occurs in some rare species of whales.

## Phil Skemer, *Assistant Professor, Rock Mechanics*

Phil Skemer is an experimental rock-mechanicist who studies the physical properties of rocks at high temperature and pressure. His lab is centered on high pressure rock deformation apparatuses, which can simulate conditions in the Earth that are inaccessible to direct observation. The objective of his research is to provide new frameworks for interpreting geophysical data and constructing numerical models of planetary interiors.

## Bill Smith, *Professor, Planetary Physicist*

Bill Smith's research centers upon development and application of high-reliability instruments for space, airborne, and ground-based environmental remote sensing. He tackles difficult problems of remote sensing in applications that range from the bottom of the oceans to outer space.

## Slava Solomatov, *Professor, Theoretical Geophysicist*

Slava Solomatov develops theoretical models of planetary evolution and investigates questions like why does only the Earth have plate tectonics, what caused the Martian hemispheric dichotomy, and why was Venus flooded with volcanic lavas in its recent geologic history. He uses both analytical and computational techniques and often requires the use of high-performance computers.

## Doug Wiens, *Department Chair, Seismologist*

Doug Wiens uses seismic imaging to investigate tectonic processes in the crust and upper mantle. He is particularly interested in studying mantle flow and the processes of melt generation in island arcs and back arc spreading centers, as well as the seismological structure of Antarctica. He also uses seismic waves to study exotic seismic sources, such as deep earthquakes and large glacier slip events.

## Michael Wysession, *Associate Professor, Seismologist*

Michael Wysession uses seismic waves as a means of investigating the structure, temperature, composition, and dynamics of the mantle. Particular areas of interest include seismic attenuation in the mantle and the dynamics of the core-mantle boundary region.

## Anne Hofmeister, *Research Professor, Mineral Physicist*

Anne Hofmeister's work entails measuring how matter interacts with light and heat, and in developing theoretical models to explain these phenomena on scales from the microscopic to the cosmic. Her work in thermodynamics, heat transfer, and infrared physics explains the origin of axial spin in stars and planets, the role of dust in their formation, initial thermal states of these objects, and the origin of light elements in planetary cores.

## Randy Korotev, *Research Professor, Lunar Geochemist*

Randy Korotev uses the chemical composition of lunar materials as a tool for understanding lunar geology. His research focuses on meteoroid impacts as a geologic process on the Moon, modification of the Moon by large and small impacts, and the nature of the early lunar crust. With his colleagues, he measures the chemical composition of lunar samples and meteorites using a variety of analytical techniques.

## Katharina Lodders, *Research Professor, Cosmochemist*

Katharina Lodders' research is in astronomy, cosmochemistry, and planetary sciences. She uses theory and experiments to study the abundances of the chemical elements and the chemistry in stars and stellar environments. Her research papers include topics about the abundances of the elements in the solar system, the formation of star dust from evolved stars, chemical processes in the solar nebula and accretion disks, formation of meteorite parent bodies, planetary accretion & differentiation, and the chemistry in atmospheres of giant planets, exoplanets, brown dwarfs, and low-mass stars. She is author of two books: "*Chemistry of the Solar System*" (coauthored with Fegley), and "*The Planetary Scientist's Companion*" (coauthored with Fegley).

## Alian Wang, *Research Associate Professor, Spectroscopist*

Alian Wang's team studies the thermodynamic and kinetic properties of hydrous minerals under the environmental conditions relevant to those at the surface and subsurface of terrestrial planets, using Laser Raman, mid-IR, Vis-NIR, and laser-induced breakdown spectroscopies. Development of science instruments for planetary missions, terrestrial analog sites studies, and instrument tests in the field are other activities of this group.

## Ernst Zinner, *Research Professor, Astrophysicist*

The main focus of Ernst Zinner's research is the study of stardust, tiny grains that condensed in stellar atmospheres and were preserved in primitive meteorites. A major component in his studies is the isotopic analysis of individual grains in the ion microprobe (NanoSIMS). Their isotopic compositions provide information on stellar nucleosynthesis and the evolution of the elements in the Galaxy.