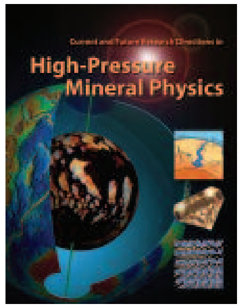
A Vision for High-Pressure Earth and Planetary Sciences Report: THE BASS REPORT

The field of high-pressure Earth and planetary sciences has changed dramatically over the past decade. Increasingly sophisticated tools are being used to investigate the properties of matter under the extreme pressure and temperature conditions of planetary interiors. As a prime example, modern synchrotron X-ray sources have presented enormous opportunities for new types of experimentation at high pressure. In parallel with these advances in large centralized facilities, new types of high-pressure devices have been developed to take advantage of them. In numerous related areas, similar progress can be seen, for example, the computational power available for calculations of mineral properties and new facilities to perform neutron scattering studies at high pressure. As a result, it is now possible to do experiments that were not dreamed of 10 years ago. Many of these exciting advances and prospects for the future have been described in the report "Current and Future Research Directions in High-Pressure Mineral Physics."

This report is an outgrowth of the discussions and results of a workshop entitled "A Vision for High-Pressure Earth and Planetary Sciences Research: The Planets from the Surface to the Center," which was held on March 22–23, 2003 in Miami, Florida. The NSF Division of Earth Sciences commissioned and supported this workshop, which was organized by COMPRES (Consortium for Materials Properties Research in Earth Sciences). Fifty-five scientists attended the workshop convened by Jay Bass and Don Weidner. The report was edited by Jay Bass, in collaboration with Ellen Kappel of Geosciences Professional Services Inc., using the materials presented at the workshop or arising from its discussions.

The report describes a number of the major scientific achievements and technological advances that have occurred over approximately the last decade. It also outlines a number of the prominent scientific issues and technological goals in the area of high-pressure mineral physics. The report is organized according to the different pressure regimes that characterize basic Earth structure and processes. These regimes include Earth's core, where the pressure is 360 GPa (3.6 Mbars); the core–mantle boundary; the mantle and crust, where subduction occurs; and finally the near-surface environment, where pressures are relatively modest, from several hundreds to only a few atmospheres. Looking out toward the other bodies in our solar system, the report concludes with issues related to planetary processes, ranging from the dynamics and compositions of planetary interiors to impacts and volcanism on the icy satellites.

For each of the areas mentioned above, scientific progress and discovery has been closely tied to technological innovation. The report gives many examples of new technology that has been brought on line within the last few



years to examine the behavior of materials at extreme pressure and temperature conditions. Some examples include: inelastic X-ray scattering techniques to measure sound velocities and the electronic structure of lower mantle and core-forming materials; the growth of large diamond anvils for a new generation of large-volume diamond cells that can be used with neutron scattering; sound velocity and elasticity measurements at high pressures and temperatures using vibrational spectroscopy on samples squeezed in diamond cells, and simultaneous ultrasonics + synchrotron X-ray experiments on samples in a multi-anvil apparatus; and rheology experiments at transition zone pressures under precisely defined stress states.

Much of the new technology available for high-pressure mineral physics research is related to synchrotron radiation facilities. The enormous intensity and penetrating power of synchrotron X-ray sources make possible experiments that cannot be done otherwise. Along with the high intensity has come extraordinary energy resolution, on the order of a milli-electron volt, allowing a variety of inelastic X-ray scattering experiments at high pressures. Sound velocities in mantle and core materials can be measured via X-ray scattering from phonons and by nuclear resonant inelastic scattering (NRS) from Fe-bearing phases. Mössbauer spectroscopy can be used to determine the valence state of Fe, and the phonon density of states can also be determined using NRS. This array of new techniques is available for experiments at high pressures and temperatures with the laser-heated diamond anvil cell. Brillouin spectroscopy and ultrasonic interferometry are now possible at central beamline facilities for simultaneous velocity and density measurements. Strains and anelastic relaxation can be measured on small samples that are buried deeply within the pressure assemblies and gasketing of a multi-anvil apparatus. It is remarkable that such a diverse array of new devices and facilities have appeared in only one decade, making possible classes of experiments that simply could not be done before.

This report should be of interest to all Earth scientists, and especially to scientists in fields of high-pressure research. Copies of the report can be downloaded at www.compres.us; hard copies are available from Ms Ann Lattimore, Administrative Coordinator, COMPRES, ESS Building, Stony Brook, NY 11794-2100, USA.

Jay Bass
jaybass@uiuc.edu

Conference Reports

PERALK, a Workshop on Peralkaline Rocks

Participants of PERALK assembled for the traditional group photograph.
PHOTO BY DAVID LENTZ

After attending two huge (6,000+) congresses, I found it most refreshing to attend the workshop entitled "Peralkaline Rocks: Sources, Economic Potential, and Evolution from Peralkaline Melts." The meeting was held in Tübingen, Germany on March 4–6, 2005, with approximately 70 scientists in attendance. The meeting was convened and ably organized by Gregor Markl, of the Institut für Geowissenschaften, Universität Tübingen. He and his enthusiastic associates have been focusing their attention lately on the peralkaline complexes of the Gardar Province, South Greenland, and in particular on the unique attributes of the Ilímaussaq Complex. Thus, through poster presentations and Gregor's talk on the parameters governing agpaitic crystallization, this group was able to showcase its recent accomplishments. The oral and poster presentations were subdivided into three major themes: Melt sources and melt generation, Crystallization conditions and magmatic evolution, and Late-stage processes and economic potential.

There were ooohs and aaahs during the slide and video presentation by Jurgis Klaudius on recent natrocarbonatitic activity in the northern crater of Oldoinyo Lengai, Tanzania, the world's only volcano spewing forth natrocarbonatitic lava. It was fascinating to witness the incredible mobility of such lava and the ephemeral nature of the fresh rocks formed; within three or four days, the bulk composition and the mineral assemblages had already changed! The primary minerals, including sylvite (found even as a phenocryst phase!), halite, gregoryite, and nyerereite, soon give way to an assemblage rich in pirssonite and gaylussite. The rocks get partially dissolved upon the first signs of rain, and the ultimate fate of a good part of the natrocarbonatite lava lies in Lake Natron, a few kilometers away.

In addition to seeing memorable presentations on Oldoinyo Lengai and Ilímaussaq, I was most interested to be brought up to date on the peralkaline rocks of Ethiopia, Pantelleria, Kenya, and the Kola Peninsula, and on parallel experimental and melt-inclusion studies on relevant systems. Even on a small scale, it was a smorgasbord of alkaline delights, and a bit of an information overload! The Program and Abstracts Volume, compiled by Michael Marks, will be an indispensable document for understanding the fine points made by the various contributors. A more permanent and widely available compilation of articles will be assembled, refereed, and published as a thematic issue of *Lithos*.

An event of this type, focused on peralkalinity in magmas, either oversaturated or undersaturated in silica, has been a very long time in coming. The feeling of participating in a rare event made attendees from far and wide really relish their weekend in Tübingen.

Robert F. Martin, McGill University, Montreal, Canada
bobm@eps.mcgill.ca

Mineral Matters

People Behind Mineral Names

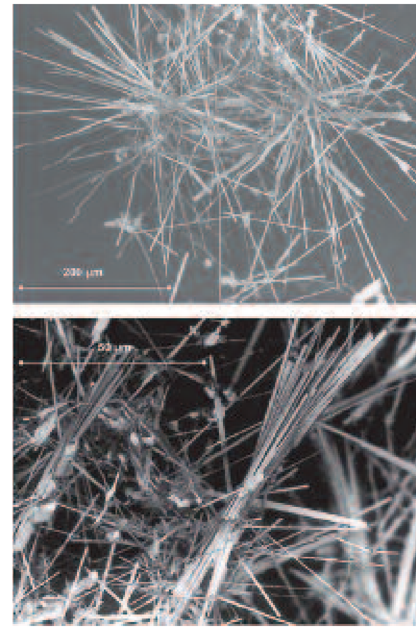
Vurroite, after Filippo Vurro

The new mineral species *vurroite*, a sulfosalt with the ideal formula $Pb_{20}Sn_2(Bi,As)_{22}S_{54}Cl_6$, was recently discovered among the high-temperature products of fumarolic activity at the Fossa crater of the volcano Vulcano, in the Aeolian Islands of Italy (Garavelli et al. 2005). It is appropriately named after Filippo Vurro (b. 1940), professor of mineralogy at the University of Bari, in recognition of his important contributions to the mineralogy and geochemistry of modern volcanic deposits.

Filippo and co-investigators have formulated a geochemical model in which the ratio Br/Cl in sal ammoniac (NH_4Cl) is considered to be a reflection of inputs of magmatic gases feeding the fumaroles, and a thermochemical model for the transport of ore-forming metals in the high-temperature gaseous stream. He participated in the crystal-chemical and crystallographic characterization of rare phases in the systems $PbS–Bi_2S_3$ and $PbS–As_2S_3–Bi_2S_3$, and of the species barberiite [NH_4BF_4], mozgovaite [$PbBi_4(S,Se)_7$], and mutnovskite [$Pb_2AsS_3(I,Cl,Br)$], which also have Vulcano as a type locality.

Filippo began his career in the Air Force chemical laboratory in Bari. With his strong background in chemistry, he naturally was attracted to undertake geochemical and mineralogical investigations of the fumarolic sublimates at Vulcano, a tremendous natural laboratory and one of only a handful of volcanoes around the world where serious investigations of the products of gaseous transfer have been carried out. The lab work takes place on the flank of the volcano.

The experiments are ongoing and uncontrolled, and equilibrium conditions are probably not attained in such a fluctuating environment. The field work, which is challenging owing to the toxicity of the gas phase and the ever-changing direction of the air currents, involves careful monitoring of the temperature and gas compositions at well-established fumaroles and requires repeated sampling of mineral sublimates and encrustations. The temperature of gaseous emissions fluctuates in a secular fashion; the type material was collected at a stage of relatively high-temperature deposition, at 607°C, although it is also deposited at other fumaroles on Vulcano over the interval 406–430°C. Vurroite is an example of a multicomponent sulfosalt in which Sn and Cl are essential constituents, along with Pb, Bi, As, and S. It also contains minor Br and traces of Tl and Se.



The acicular habit of vurroite is typical of other sulfosalts deposited under conditions of rapid crystallization as the high-temperature gaseous emanation cools and mixes with the atmosphere.

Robert F. Martin
(bobm@eps.mcgill.ca)

REFERENCE

Garavelli A, Mozgovav NN, Orlandi P, Bonaccorsi E, Pinto D, Moëlo Y, Borodaev YuS (2005) Rare sulfosalts from Vulcano, Aeolian Islands, Italy. VI. Vurroite, $Pb_{20}Sn_2(Bi,As)_{22}S_{54}C_{16}$, a new mineral species. Canadian Mineralogist 43: 703-711