

Newsletter

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The Third Annual Meeting of COMPRES



On June 19-22, the 3rd Annual Meeting of COMPRES took place at the Granlibakken Conference Center in Lake Tahoe, California. 79 scientists from 28 US member institutions and 2 foreign affiliates participated the meeting. An introduction and brief review of COMPRES' three year milestones by the president, Robert Liebermann, started the meeting. Three plenary lectures "Recent Developments in Synchrotron Facilities" by Chi-chang Kao, "Mantle Heterogeneity and Dynamics Members" by Richard O'Connell, and "Global Seismic Tomography: Current Status and Future Directions — What can a mineral physicist really believe?" by Guy Masters highlighted some of the challenging

scientific frontiers. Reports from the Community Facilities, Infrastructure Development projects, COMPRES-related workshops presented the most update information and future plans to the participants. Four Grand Challenge talks and thirty seven posters revealed the recent exciting scientific results from the COMPRES community. During the business meeting held as the last part of the annual
(continued on next page)



*See more photos
from the Annual
Meeting on page 9-
12.*

IN THIS ISSUE:

The 3rd Annual Meeting	1
President's Message	2
Our Appreciation to Don	4
Committee Member Update	4
Honorary Degree Awarded to the President	5
New Infrastructure Development Project ...	6
Recent PhDs	7
COMPRES Beamline Interns Selected	8
Mourning the Loss to Our Community.....	8
The 3rd Annual Meeting Snapshots.....	9

Annual Meeting

(Cont'd)

meeting, representatives of member institutions elected new officers and members of Executive and Standing Committees, and discussed the recommendations of ByLaws Committee. An Advisory Committee meeting (with the Executive

Committee) was held prior to the Annual Meeting on June 18-19 at the same site. Most of the Advisory Committee members and the Program Director for Geochemistry in the Division of Earth Sciences at the NSF also attended the Annual Meeting. ■ ■ ■

President's Message

COMPRES has now reached the age of 2 and held its 3rd Annual Meeting. Following are some of the highlights of activities of the COMPRES and related communities during the period April to June 2004.

As part of a program to visit experimental laboratories in mineral physics in the U. S. and overseas, I visited the diamond-anvil cell, high-pressure laboratory of Surendra Saxena at the Florida International University on April 5-6 and gave an invited talk on: "Sound Velocity Measurements in Minerals under Mantle Conditions." On April 23, 2004, I visited the Laboratoire des Mécanismes de Transfert en Géologie in Toulouse, France. While there I was able to observe the move of this lab from their current location on Allées Jules Guesde near the Jardin des Plantes to the Ranguel campus where most of the laboratories of the Université Paul Sabatier and the CNRS are located.

In April, the following members/friends of the COMPRES community have recently been elected to membership in the U. S. National Academy of Sciences:

Donald Helmberger--California Institute of Technology

Raymond Jeanloz--University of California at Berkeley

Dennis Kent--Rutgers, The State University of New Jersey at New Brunswick

David Stevenson--California Institute of Technology

We send our heartiest congratulations on behalf of the COMPRES community. These distinctions, in addition to recognizing their significant achievements and contributions, brings honor and visibility to the community of mineral and rock physicists throughout the world.

On May 2, a Workshop on High Pressure Rheology was convened by Shun Karato at Yale University in New Haven, which included all the principal members of the team for the Rheology

Grand Challenge project. See details on the COMPRES website.

At the 2004 Users Meeting for the Advanced Photon Source [May 3-6], Jennifer Jackson of the University of Illinois won an award for the outstanding student poster for her presentation on "(Mg,Fe)SiO₃ perovskite to 120 GPa using synchrotron Mossbauer spectroscopy". Jennifer was also recently awarded an MSA Grant for Student Research in Mineralogy and Petrology for her study of "Sound Velocities of aluminous MgSiO₃ perovskite under high-pressure and high-temperature conditions using Brillouin spectroscopy and laser heating."

On May 8, Jay Bass convened an Elasticity Grand Challenge Workshop at the University of Illinois in Urbana-Champaign. More than 29 graduate students, postdocs and faculty attended. See details on the COMPRES website.

In early May, Russell Hemley was invited to give the Third Annual Earth Day Distinguished Lecture at the National Science Foundation by the

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Opening of the 3rd Annual Meeting of COMPRES

President's Message

(Cont'd)

Geoscience Directorate. Rus spoke on recent Developments in Earth science under the title: "Diamond Windows on a New Science."

On May 24-25, a "Workshop on Geoscience User Facilities—Enhancing Instrumentation Access" was convened in Gaithersburg, Maryland, under the auspices of the DOE Council on Earth Sciences by Steve Sutton, Richard Reeder and Marc Caffee.

Without question, the most significant event of the past four months was the 3rd Annual Meeting of COMPRES, which was held at the Granlibakken Conference Center in Lake Tahoe, California from June 19-22, 2004. There were 81 formal participants plus another 15 accompanying persons [including some very young, but very promising future mineral physicists]. More than 28 of the 39 U. S. member institutions were represented, as well as one foreign affiliate [GeoForschungs Zentrum from Potsdam, Germany]. The program included Plenary Lectures, reports from the operators of the Community Facilities and directors of the Infrastructure Development projects, reports on past and future workshops, and exciting scientific results in the poster sessions. We were especially pleased that Sonia Esperanca, Program Director for Geochemistry in the Division of Earth Sciences at the NSF attended the entire meeting, and that Herman Zimmerman, Division Director for EAR paid a call at the end of the meeting. We all owe a special thanks to Ann Lattimore for organizing and coordinating such a successful meeting.



The 3rd Annual Meeting of COMPRES

On June 18-19, 2004, just prior to the Annual Meeting, there was a meeting of the COMPRES Advisory Committee with the Executive Committee. All members of the Advisory Committee were in attendance for the first time: Bruce Buffett from the University of Chicago, Chi-chang Kao from Brookhaven National Laboratory, Guy Masters from the University of California at San Diego, Richard O'Connell from Harvard University and Paul Silver from the Carnegie Institution of Washington. The chairs of the COMPRES committees made brief presentations, followed by very useful discussions. Three of the Advisory Committee [Kao, Masters and O'Connell] also gave Plenary Lectures at the Annual Meeting.

On June 21-22, the Annual Business Meeting of COMPRES was held, including election of new officers and committee members as well as consideration of the report and recommendations of the ByLaws Committee [Bruce Buffett, Ronald Cohen (Chair), Charles Prewitt, Joseph Smyth, and Lars Stixrude]. The results of the elections are as follows:

Chair of the Executive Committee:

Harry Green (2004-2007)

New Member of the Executive Committee:

Donald Weidner (2004-2007)

New Member of Facilities Committee:

Abby Kavner (2004-2007)

Chair of the Infrastructure Development Committee:

Nancy Ross (2004-2006)

New Member of the Infrastructure Development Committee:

Sang-hyeon (Dan) Shim (2004-2007)

We congratulate the new officers and members of committees and thank all those who agreed to stand for election. We also thank the following officers and members whose terms ended at the Annual Meeting: Harry Green (Facilities Committee), Janes Tyburczy (Chair of Infrastructure Development Committee) and Donald Weidner (Chair of Executive Committee).

During the past four months, applications from the following institutions have been unanimously approved by the Executive Committee for membership in COMPRES:

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President's Message

(Cont'd)

Institut de Physique du Globe de Paris-IPGP

Representative: Guillaume Fiquet.

Eidgenossische Technische Hochschule (ETH)- Zurich (Switzerland)

Representative: Artem Oganov.

California Institute of Technology

Elector: Paul Asimow,

Alternate Elector: Thomas Ahrens.

University of Manchester (United Kingdom)

Representative: Alison Pawley.

These new additions bring the total number of U. S. institutional members to 40, with 14 foreign affiliates.

Best regards,
Bob Liebermann

Our Appreciation to Don, the First Chair of Executive Committee By Harry Green

As the new Chair of the Executive Committee of COMPRES, I would like my first official action to be expression of great thanks to the outgoing Chair, Don Weidner for his outstanding job in launching our consortium. It is difficult to convey how extraordinarily important Don has been to COMPRES. Not only has he served as the Charter Chair of the consortium but to a great extent COMPRES has come into existence because of Don's vision and very hard work. It was Don who took the lead to develop a new concept for collaborative High Pressure Mineral Physics in the US as CHiPR was drawing to a close. At one "town hall" meeting after another, it was Don up in the front of the room drawing out the ideas of the community and guiding us toward the vision that was finally fleshed out in San Diego. Then it was Don who served as PI on the initial proposal and, although I don't have first hand knowledge of the final proposal construction, I am sure that Don's efforts and skills were very much in evidence. To our great advantage (especially to my great advantage), Don will continue to serve on



the Executive Committee, hence we will continue to benefit from his counsel as we move on toward the critical first renewal of COMPRES. Thanks Don!! We look forward to many more years of your contributions to COMPRES and to Mineral Physics. ■

Committee Member Update

(Effective June 22, 2004)

Executive Committee:

- Harry Green, Chair (909) 787-4505 (hgreen@mail.ucr.edu), 2004-2007
- Jay Bass, (217) 333-1018 (bass@hercules.geology.uiuc.edu) 2003-2006
- Shun-ichiro Karato, Vice Chair (203) 432-3147 (shun-ichiro.karato@yale.edu) 2002-2005
- Robert Liebermann, President, 631-632-1968 (robert.liebermann@sunysb.edu) 2003-2007
- Donald Weidner, (631) 632-8211 (dweidner@sunysb.edu) 2004-2007
- Mark Rivers, Chair of Facilities Committee - non-voting advisor (630) 252-0422 (rivers@cars.uchicago.edu)
- Nancy Ross, Chair of Infrastructure Development Committee - non-voting advisor (540) 231-6356 (nross@vt.edu)

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Committee Member Update (Cont'd)

Facilities Committee:

- Mark Rivers, Chair 2003-2005, (rivers@cars.uchicago.edu) 2002-2005
- Thomas Duffy (duffy@princeton.edu) 2003-2006
- Yingwei Fei (fei@gl.ciw.edu) 2002-2005
- Charles Prewitt (prewitt@gl.ciw.edu) 2003-2006
- Sang-hyeon (Dan) Shim (sangshim@MIT.EDU) 2004-2007

Infrastructure Development Committee:

- Nancy Ross Chair 2004-2006 (nross@vt.edu) 2003-2006
- Pam Burnley (burnley@gsu.edu) 2002-2005
- Abby Kavner (akavner@igpp.ucla.edu) 2004-2007
- Kevin Righter (kevin.righter-1@nasa.gov) 2003-2006
- Yanbin Wang (wang@cars.uchicago.edu) 2002-2005

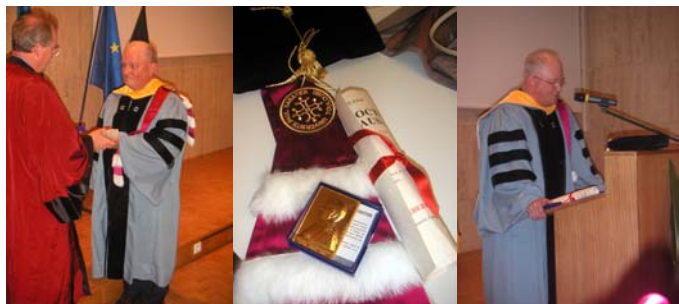
Honorary Degree Awarded to the COMPRES President

On April 23, 2004, Professor Robert Liebermann of Stony Brook University received an honorary degree [Docteur Honoris Causa] from the Université Paul Sabatier in Toulouse (France) for his pioneer efforts in promoting scientific collaborations between US and France and his outstanding contributions to the experimental research for understanding the composition and structure of Earth's interior. Since the 1980's, Bob has been actively and continuously collaborating with Université Paul Sabatier in a wide range of geophysics research and training many young scientists from the university. He spent his most recent sabbatical year in Toulouse before returning to the U. S. to take up the COMPRES presidency. He is recognized as a dear friend and a world-wide renowned geophysicist. Three other awardees including the 2002 Physics Nobel Prize Winner, Riccardo Giacconi, joined Bob to receive the honorary degree. Great congratulations to Bob.



Professor Olivier Jaoul presented Bob at the ceremony:

"This is a real pleasure, and an honor, for me to present Professor Robert Liebermann for the title of Docteur Honoris Causa of our University.... I kept a close relationship with Bob since we first met in Czech Republic in 1976 during a meeting in Liblice. Bob was already well known for his work in geophysics, and I was only a young scientist that came to this meeting to find out what was the link between solid state physics and geophysics. I received a personal welcome from Bob at this meeting and he introduced me to very famous geophysicists. This has been a determining factor for my choice to pursue a career in this branch of Earth Sciences."



New Infrastructure Development Project

Nuclear Resonant Scattering at High P & T: A New Capability for the COMPRES Community

Nuclear Resonant Scattering (NRS) techniques are relatively new applications of synchrotron radiation for determining the properties of condensed matter. The infrastructure development outlined here is aimed at creating state-of-the-art NRS techniques for characterizing the properties of materials under the high-P-T conditions of planetary interiors. The development and advance of two related techniques are of interest: Synchrotron Mössbauer Spectroscopy (SMS) and Nuclear Resonant Inelastic X-ray Scattering (NRIXS). The applications include (but are not limited to) determining the valence states of iron, the phonon density of states, sound velocities, detection of melting, and detection of high-spin low-spin transitions, all for iron-bearing compounds of geophysical interest. It has recently been shown that SMS and NRIXS can be performed using small samples at high pressures in a diamond anvil cell.

We will develop a new experimental capability at sector 3-ID of the Advanced Photon Source and to make it accessible to the COMPRES community. We will develop laser heating of samples in a diamond anvil cell (DAC) for NRS experiments. The motivation is to characterize materials by NRS while they are at simultaneous high P-T conditions that are similar to those in the deep Earth. The feasibility of NRIXS and SMS at high pressure has already been established. Iron-containing compounds were successfully studied at pressures above 1 Mbar. However, some of the crucial issues in Earth and planetary science can only be addressed if high-P experiments are performed at simultaneous high-temperature conditions. Such a capability would be unique worldwide. Thus far, a laser heating system has been purchased and partially tested. The specific tasks to be performed under this proposal are

- Complete design, construction, and commissioning of a laser heating system suitable for NRS experiments at sector 3-ID of the Advanced Photon Source.
- Development of refined high-pressure equipment and techniques for NRS.
- Development of user-friendly instrumentation and controls to facilitate easy access of the COMPRES community to this new capability.
- Education and outreach to the Earth-sciences community to encourage the use of NRS, to develop productive collaborations, and to address common experimental issues confronting users.

For the successful and timely completion of these tasks, the project will support a full-time post-doctoral scientist who will be dedicated to developing the high-P-T infrastructure, serving its users, and building a user base among the COMPRES community. We will also organize workshops on Nuclear Resonant Scattering at High P & T. The completion of the tasks outlined in this proposal, will provide a truly unique capability for the study of vibrational dynamics and valence states of Fe under high pressure and high temperature conditions. No other facility in the world exists for such experiments. This enhancement of sector 3-ID capabilities presents an ideal synergy with developments at the beamlines of GSECARS and HPCAT, which focus on diffraction and XAFS-type methods.

Wolfgang Sturhahn, Advanced Photon Source, Argonne National Laboratory, Lemont, IL 60439, sturhahn@anl.gov

Jay D Bass, Geology Dept, University of Illinois, 1301 W Green St, Urbana, IL 61801, jay-bass@uiuc.edu

Guoyin Shen, Consortium for Advanced Radiation Sources, University of Chicago, Chicago, IL 60637, shen@cars.uchicago.edu



Recent PhDs



Motohiko Murakami, Ph. D. 2004
Tokyo Institute of Technology, Japan

Dissertation: **Phase Transitions of Lower Mantle Minerals and Its Geophysical Implications**

Knowledge of the phase relations, crystal structures and chemistry of Earth's lower mantle materials is essential for understanding the Earth's deep interior and for evaluating seismic observations of the deep lower mantle and their geochemical and geodynamic implications. Experimental investigations of these phenomena are now possible with developed diamond anvil cell (DAC) techniques that allow us to carry out detailed studies of transformations in minerals at overall pressure and temperature conditions within the Earth's mantle. In this study, the phase transitions of lower mantle minerals in the simple system (FeO, SiO₂, MgSiO₃) and phase relations of Pyrolitic mantle were investigated by using synchrotron X-ray diffraction measurements combined with the laser-heated DAC under deep lower mantle conditions. And phase chemistry of the recovered samples in Pyrolite was also examined by analytical transmission electron microscopy (ATEM). The results can be summarized as follows:

(1) Phase transitions of FeO were investigated up to a pressure of 87 GPa and a temperature of 1730 K. Phase transition from NaCl-type to NiAs-type structure was observed above 70 GPa and 1600 K. The results also indicate that the observed NiAs-type phase might have a metallic nature that could promote the oxygen incorporation into the core. This phase transition pressure is consistent with that of the previous shock-wave compression experiments.

(2) We investigated the stability of high-pressure polymorphs of SiO₂ up to 151 GPa and 2500 K. To examine the kinetic effect to the phase

transition, we used the amorphous silica as starting materials, and the sample was heated for more than 1.5 hr to monitor the relative intensities of observed phases. The results demonstrated that the CaCl₂-type silica is a post-stishovite phase and that it undergoes further transition to the α -PbO₂-type structure above 121 GPa at 2400-K. These results agree with the theoretical prediction on the phase transition sequence of silica with increasing pressure: stishovite - CaCl₂-type - α -PbO₂-type. The α -PbO₂-type silica can be present in the deep portion of the lower mantle in the silica-saturated bulk compositions. This phase transition might contribute to the seismic wave velocity anomalies observed in the D'' region.

(3) The stability and structural change of MgSiO₃ perovskite, which is believed the predominant phase in the lower mantle, were examined under the conditions throughout the entire lower mantle up to 134 GPa and 2600 K. Our results confirmed that the orthorhombic perovskite (space group; *Pbnm*) was stable up to 114 GPa and 2300 K. The new diffraction peaks occurred during heating above 120 GPa, which cannot be explained by orthorhombic perovskite or dissociation products such as MgO and SiO₂, whereas the peaks of orthorhombic perovskite were apparently faded and weakened. Results demonstrate that MgSiO₃ perovskite transforms to a new high-pressure form with stacked SiO₆-octahedral sheet structure (space group; *Cmcm*) above 125 GPa and 2500 K with an increase in density by 1.0-1.2 %. The origin of the D'' seismic discontinuity may be attributed to this post-perovskite phase transition. The new phase may have large elastic anisotropy and develop preferred orientation with platy crystal shape in the shear flow that can cause strong seismic anisotropy below the D'' discontinuity.

(4) Phase relations and phase chemistry in pyrolitic bulk composition were studied at pressures of 40-120 GPa and temperatures up to 2550 K with high pressure and high temperature in-situ X-ray measurements and ATEM examinations. We confirmed that three phases of Mg-perovskite, magnesiowustite and Ca-perovskite were stable up to 91 GPa and 2300 K. The MgSiO₃-rich post-perovskite phase also appeared above 100 GPa, whereas magnesiowustite and Ca-perovskite were still observed. The lowermost mantle consists predominantly of this new phase with the minor amounts of Mw and Ca-perovskite. No significant changes in mineral proportions and element partitioning behavior were observed at least up to 91 GPa. However, the (Mg, Fe) partitioning coefficients ($K_{Mw/Pv}^{Fe}$) between magnesiowustite and the post-perovskite phase

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Recent PhDs

(Cont'd)

drastically changed. The phase transitions between Mg-perovskite and the new phase may be the origin of D'' seismic discontinuity, and would induce the re-distribution of Mg and Fe between magnesiowustite and post-perovskite phase. This would lead to change in the physical properties such as electrical conductivity beneath the D'' discontinuity.

Statement

It was my great pleasure to work with my adviser Dr. Kei Hirose (Tokyo Tech) and my collaborators at Tokyo Tech and SPring-8 and we could fortunately find some exciting results on the phase transitions of lower mantle minerals including the discovery of "post-perovskite phase transition in MgSiO₃" during my Ph. D. study. I am currently a

JSPS Postdoctoral Fellow at Tokyo Tech working with Dr. Kei Hirose, continuing to study the phase relations and chemistry in the deep lower mantle. My current research interest is on the physical properties of mantle minerals under extreme pressure and temperature conditions. I am going to work with Dr. Jay Bass at the University of Illinois and I would like to perform high pressure (DAC) experimental research, using Brillouin, synchrotron XRD and/or inelastic x-ray scattering to understand the dynamics of Earth's deep interior.



COMPRES Beamline Interns Selected



Two candidates (Christopher Young and Arianna Gleason-Holbrook) have been selected by the Search Committee as COMPRES Beamline Interns. Chris graduated from the University of California, Davis (Chemical Engineering major), and Arianna graduated from the University of Arizona, Tucson (Geophysics major). Chris and Arianna have decided and been approved to start their internship at high pressure beamlines at the National Synchrotron Light Source and Advance Light Source respectively.

Mourning the Loss to Our Community: Syun-iti Akimoto [1926-2004]

We are saddened to report that Professor Syun-iti Akimoto passed away on July 14 at the age of 78 after four-months in the hospital being treated for a cerebral hemorrhage. Akimoto-sensei was a giant in the field of high-pressure mineral physics and valued colleague and dear friend to many of us in the COMPRES community. He visited the U. S. on a number of occasions and often hosted visits by colleagues in Tokyo. He was the co-founder of the very successful series of Japan-U.S. Seminars on High Pressure Mineral Physics and received the William Bowie Medal of the AGU in 1983. The mineral Akimotoite [(Mg,Fe)SiO₃ of ilmenite structure] is named in his honor in recognition of his great contributions to high-pressure research.



Prof. Akimoto and his wife visiting Stony Brook High Pressure Lab in 1989



The 3rd Annual Meeting Snapshots

*(Photo by Glenn Richard
and Michael Vaughan)*



Plenary Lectures



**Breakout session
(NLSL LVP)**



**Breakout session
(APS)**

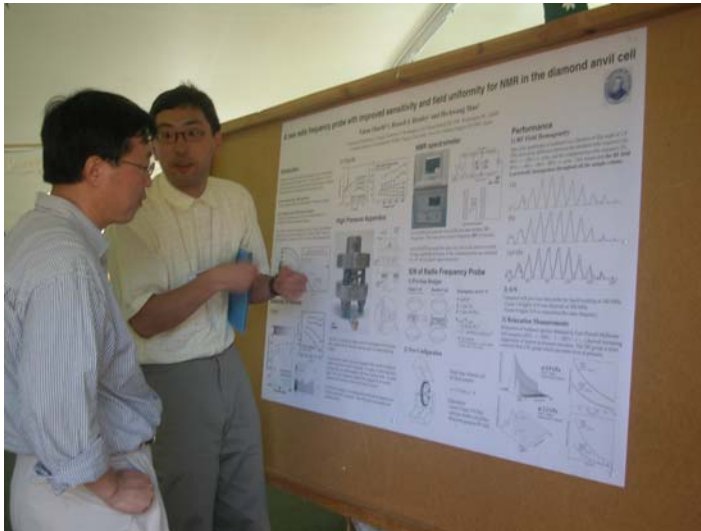


**Breakout session
(NLSL DAC)**



The 3rd Annual Meeting Snapshots

In Session





The 3rd Annual Meeting Snapshots

After hour





The 3rd Annual Meeting Snapshots

Fun Photos

The Effect of Glass ...



External

Internal



Magic show with bare hands

"I got twins"

Facing a tough question

Let the young participant speak

Sounds like a cool talk

You don't agree??

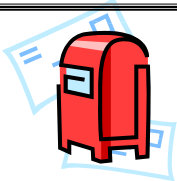
I got a comment

What ?!!

That's better

Not my business?

Oh... I'm sorry Mom



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