Newsletter
Earth Probe
COMPRES
Consortium for Materials Properties Research in Earth Sciences
http://www.compres.us Vol. 9 No.1, February 2014

2013 Annual Meeting of COMPRES

June 17 to 20, 2013 at Lake Geneva, WI

In this issue:

The 2013 COMPRES Annual Meeting was held on June 17-20, 2013 at the lovely Abbey Resort, Lake Geneva, Wisconsin. 115 participants from 44 institutions gathered to discuss research frontiers in mineral physics and beyond, review operations of COMPRES facilities and infrastructure, and elect COMPRES committee members. As a tradition of the annual meeting, one focus of the scientific agenda is interdisciplinary presentations. This year's keynote lectures included: "Mantle Redox Heterogeneity" by Elizabeth Cottrell of Smithsonian Institution, "The oldest geodynamo and shielding from the solar wind" by John Tarduno of University of Rochester, "Recent progress in theory of Earth and planetary materials" by Renata Wentzcovitch of University of Minnesota, "Physical mechanisms of transient viscoelastic behavior of polycrystalline olivine" by Ulrich Faul of

2013 Annual Meeting of COMPRES

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Boston University, "Emerging consensus on large scale shear wave speed structure in the mantle" by Vedran Lekic of University of Maryland, and "Probing the Hadean world with noble gases" by Sujoy Mukhopadhyay of Harvard University. The meeting also included fifteen contributed talks presented by Gregory Finkelstein, Yun-Yuan Chang, Daniel Hummer, Xuebing Wang, June Wicks, Pamela Burnley, Thomas Duffy, Lora Armstrong, Earl O'Bannon, Yongtao Zou, Jennifer Girard, Jin Liu, Aaron Wolf, Hongluo Zhang, and Joshua Townsend. A special banquet talk by former COMPRES President Robert Liebermann of Stony Brook University highlighted the development of in-situ acoustic measurement techniques and the role of serendipity in his career in mineral physics. Managers of COMPRES facilities Quentin Williams and Thomas Duffy updated the status of DAC beamlines at Advanced Light Source and National Synchrotron Light Source respectively. Progresses on three Infrastructure Development projects were reported by Przemyslaw Dera on Advanced Photon Source Sector 13 Gas Loading; Dongzhou Zhang on Advanced Photon Source Sector 3 Inelastic X-ray Scattering; and Helene Craigg on COMPRES Multianvil Press Assembly. New or Planned COMPRES Facilities were presented by Lars Ehm on NSLS-II XPD; Zhenxian Liu on NSLS-II FIS; Don Weidner on APS 6-BM; and Bin Chen on COMPTECH at APS. Details of the talks and titles are available at: http://www.compres.us/ index.php?option=com_content&task=view&id=177& Itemid= 226. Being nearly one third of the total participants, students were very active in this meeting. Three breakout sessions were arranged for them including one panel discussion on "Finding a Job" by panelists Kanani Lee (leader), Andrew Campbell, Przemyslaw Dera, Elizabeth Cottrell, and Yuejian Wang. The business meeting included the election of new officers for COMPRES committees (see below).

New Committee Members

At the 2013 annual meeting, new members/chairs of COMPRES committees were elected. The current membership of Executive Committee, Facilities Committee and Infrastructure Development Committee are as follows:

Executive Committee: Current Membership

Pamela Burnley UN, Las Vegas, Chair [2013-2015], Member [2013-2015]
James Tyburczy, Arizona State University, [2008-2015]
Jennifer Jackson, Caltech, [2013-2016]
Quentin Williams, UC, Santa Cruz, [2013-2016]
Yingwei Fei, Carnegie Institution of Washington, [2012-2014]

Facilities Committee: Current Membership

Andrew Campbell, University of Chicago, Chair [2011-2015], Member [2008-2016]
Kanani Lee, Yale University, [2013-2016]
Kurt Leinenweber, Arizona State University, [2012-2015]
Jung-Fu Lin, University of Texas at Austin, [2012-2015]
Yanbin Wang, University of Chicago, [2008-2014]

Infrastructure Development Committee: Current Membership

Abby Kavner, University of California Los Angeles, Chair [2012-2014], Member [2009-2015]
Elizabeth Cottrell, Smithsonian Institution, [2013-2016]
Jie Li, University of Michigan, [2013-2016]
Elise Knittle, University of California at Santa Cruz, [2011-2014]
Steven Jacobsen, Northwestern University, [2008-2014]

Message from the President

Jay Bass

Dear Members of the COMPRES Community:

With this issue of the COMPRES Newsletter, it's my pleasure to revive a tradition that was established by **Bob Liebermann** when he was President of COMPRES. The first item in this message is a heartfelt "thank you!" to Bob for his exemplary leadership as President of COMPRES. During his presidency, the consortium grew in membership by over three-fold and has thrived in all aspects of its activities.

In the remainder of this message I will run through a few of the more substantial events and changes since I started as President in January 2010. First in this list is a change in the management of the COMPRES-supported beamline 12.2.2 at the Advanced Light Source (ALS) (otherwise known as the West-Coast Synchrotron Facility). The management was moved from University of California at Berkeley, with **Raymond Jeanloz** and **Simon Clark** as PI's, to **Quentin Williams** at UC Santa Cruz. I would like to thank Raymond and Simon for their dedicated management of 12.2.2 up to 2010. Quentin Williams has built upon the momentum established by Raymond and Simon to further improve the beamline for hard X-ray diamond cell research, start a number of upgrades, and nurture growth of the high-pressure Earth science user base at 12.2.2. This facility continues to be productive and is a major infrastructure resource for the COMPRES community on the West Coast and throughout the US. Thanks to Quentin for his steady and dedicated leadership. We will have a highlight on beamline 12.2.2 in a future issue of the COMPRES newsletter.

The latter part of 2010 and up through September 2011 was spent working on the COMPRES renewal proposal, which was successful. A new COMPRES Cooperative Agreement was issued following external peer review (which for the most part gave glowing marks to COMPRES) and a site visit held at the NSLS & NSLS-II, Brookhaven National Laboratory. Our 5-year Cooperative Agreement is funded at $2.4M per year until May 31, 2017. My thanks to the many people who contributed to the renewal proposal in many ways. I am especially thankful to **Tom Duffy**, who was serving as Chair of the Executive Committee during the proposal process. Tom gave a great deal of his time and made many invaluable contributions to the renewal proposal. I'm grateful for having had Tom as a collaborator on this daunting task (~475 pages, in total). A copy of the COMPRES renewal proposal is available on our website (www.compres.us), under the "Publications" tab. A number of new projects will be initiated during our current Cooperative Agreement. One of them, COMPTECH (**Przemek Dera**, PI), is described in an article in this newsletter.

As most of you know by now, the National Synchrotron Light Source (NSLS) will be closing operations on September 30, 2014, and this has presented some serious challenges for our community. COMPRES has supported three facilities at the NSLS since the inception of the consortium: The DAC Infrared spectroscopy beamline U2A; the hard X-ray large-volume Multi-Anvil Press facility at beamline X17B2, and the hard X-ray diamond cell diffraction beamlines X17B3 and X17C. These facilities have served our community well over the past 11 years, and have been productive. We are proud to announce that the IR program has been chosen as one

Message from the President

Jay Bass

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of the NxtGen beamlines to be built at the NSLS-II. Our congratulations to **Zhenxian Liu** and **Rus Hemley** for putting together a compelling case for having IR spectroscopy at extreme conditions as part of the NSLS-II, and being chosen as one of the few successful beamline proposals in tough competition. We will also be partner users at the XPD beamline, occupying a hutch for large-volume multi-anvil rheology and elasticity research, and for diamond-anvil cell X-ray diffraction. This effort was led by **Don Weidner**, the current manager for X17B2 at the NSLS. XPD is one of 8 "Project" beamlines built into the construction budget of the NSLS-II, and was spearheaded by the materials sciences community for general X-ray diffraction. An article on COMPRES at NSLS-II is included in this issue.

In order to maintain necessary beamtime for our community during this transition period and into the future, COMPRES is entering an exciting new phase of operations at the Advanced Photon Source (APS). We will be developing two new end-stations to minimize the disruption of the NSLS closure on our community. One facility will be a partnership of COMPRES and GSECARS named PX^2, which will be located at the 13-BMC end-station. This facility, with **Przemek Dera** of University of Hawaii as PI, will be for hard X-ray diamond-anvil cell powder and single-crystal diffraction. PX^2 will help to replace COMPRES facilities now at the X17B3 and X17C beamlines. It will include laser heating, and some capabilities will be enhanced compared to the current NSLS facilities. The other APS facility in the works is at beamline 6-BM-B. This beamline will be for rheology experiments with the 250-ton D-DIA press or rotational Drickamer apparatus, and high-pressure ultrasonics elasticity measurements. This facility will utilize white X-rays, as currently used at NSLS beamline X17B2. **Don Weidner** of Stony Brook University is the PI on this project. With the development of these APS beamlines, I feel that the COMPRES community will continue to be well served with world-class synchrotron facilities for their research.

The COMPRES Distinguished Lecture series continues to thrive as a highly successful activity. Our target audience for this outreach program is four-year colleges and institutions that do not have a mineral physicist on the faculty. The Lecture Series is heavily oversubscribed with requests each year. **Heather Watson** of Rensselaer Polytechnic Institute is organizing the Lecture Series this year, after two-years of leadership by **James Tyburczy**. This year's lecturers are **Jennifer M Jackson** of CalTech, and **Mark Frank** of Northern Illinois University. The 2012-2013 Distinguished Lecturers were **James Tyburczy** of Arizona State University, and **Elizabeth Cottrell** of the Smithsonian Institution. Thanks to all of the Lecturers and organizers for taking time out of your busy schedules to spread the word about Mineral Physics and COMPRES. Information on the lectures for the 2013-2014 tour are given on the COMPRES website (www.compres.us).

The memberships of the COMPRES Executive Committee and Standing Committees for 2013-2014 are listed in this newsletter. In addition to thanking all who are serving or have served in the past on COMPRES committees, I want to thank everyone who agreed to have their names on the past ballots for new committee members. These include: Przemek Dera, Joseph Smyth, Donald Weidner, Guoyin Shen, Jiuhua Chen, Lars Ehm, Donald Isaak, Gabriel Gwanmesia and Matthew Whitaker. We greatly appreciate your willingness to serve COMPRES, and I'm hope we can call on you again in the future.

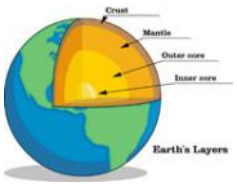
Prof. **Jiuhua Chen** has graciously agreed to resume his Editorship of the COMPRES newsletter, with help from **Chong-Hwey Fee** of the COMPRES Central Office. Thanks to both of you for your work in making this newsletter possible.

We hope to see you all at the COMPRES Annual Meeting this June, at the Skamania Lodge in Stephenson WA (June 16-19). This will be the kickoff event for organizing our community for the COMPRES renewal proposal.

Please come and make your voices heard!

Sincerely,

Jay Bass



COMPTECH

The COMPRES Technology Center (COMPTECH) is a new COMPRES Facility project at the Advanced Photon Source, Argonne National Laboratory. COMPTECH, which was launched in April, 2013, and gives COMPRES a greater presence at the APS.

With its storage ring operating at an electron energy of 7 GeV, the experimental stations at APS offer a significantly higher flux of hard x-rays (above 20 keV), which are more suitable for high-pressure experiments, than other synchrotron sources in the country. APS beamlines are heavily utilized by members of the COMPRES community to carry out their research. APS is currently in the initial stage of a major midterm upgrade which will significantly boost the current capabilities and increase the amount of beam time available to users. This will be done by canting most of the existing insertion devices and creating new experimental stations.

Since its inception, COMPRES has maintained its presence at APS by funding Infrastructure Development projects located at high-pressure beamlines (Sectors 3, 13, 16). Many of these projects have been very successful and have had a significant impact on the COMPRES community and their research productivity, as well as on the APS itself. The main mission of the COMPRES Technology Center (COMPTECH) at Argonne is to develop new capabilities for high-pressure Earth science using advanced state-of-the art techniques at existing APS beamlines.

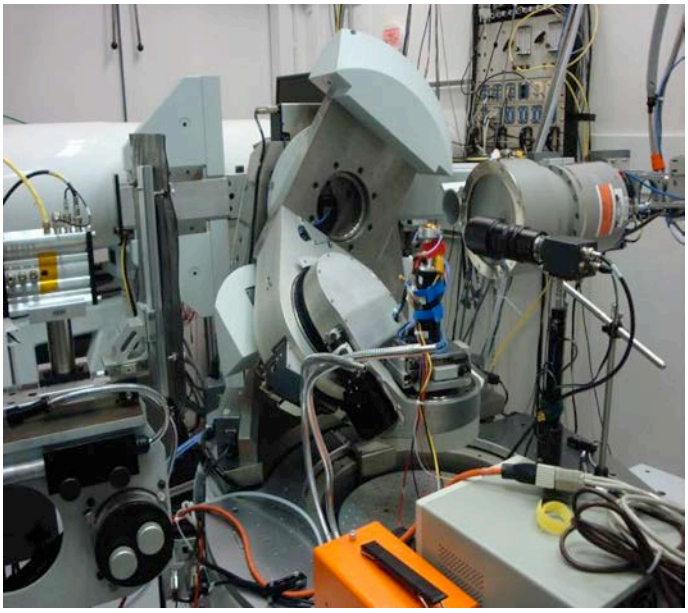
Partner User Proposals will be sought at various beamlines and used for development of high-pressure capabilities and preferential access for the COMPRES community. The location of the COMPTECH at the Argonne Laboratory brings several significant advantages: (i) APS hosts a variety of unique, state of the art instruments and dedicated beamlines, and engages in development of novel forefront experimental technology (ii) ANL hosts several current COMPRES projects, with on-going plans to establish more permanent COMPRES facilities though PUP proposals; (iii) ANL provides an outstanding environment for high-pressure science and technique development. At APS there are many resident experts on the newest synchrotron technologies, software development, and a wide spectrum of high-pressure researchers, all of whom are interested in collaborating with COMPTECH, (iv) the lab is a short driving distance from two major airports; (v) it is located at a central research facility frequently visited by the majority of COMPRES synchrotron users, which should stimulate new collaborations.

The COMPTECH facilities and activities are managed by its Program Director, Dr. Przemek Dera (pdera@hawaii.edu) with continuing assistance from former Chief Technology Officer, Dr. Bin Chen (binchen@hawaii.edu). For more details about the COMPTECH please visit http://comptech.compres.us.

COMPRES and Partnership for Extreme Crystallography

In situ high-pressure crystallography has been one of the principal analytical tools of Mineral Physics research and has significantly contributed to the development of our field. The concepts of comparative crystal chemistry, isostructural surfaces in the pressure-temperature-composition space, crystal-chemical trends, etc. have all been coined and developed largely based on pioneering single-crystal experiments (SXD) conducted since 1970's. Our knowledge of a majority of reversible high-pressure phase transitions and the nature of non-quenchable high-pressure phases comes almost exclusively from *in situ* crystallographic investigations. "Traditional" single-crystal diffraction experiments have been done mostly with laboratory X-ray sources and were limited to pressure of about 10 GPa or less, and ambient temperature. These limitations make it quite challenging to extrapolate trends in the detailed compression mechanisms to the actual conditions of interesting geologic environments. Moreover, conventional laboratory SXD has been thought to be of limited application to cases of structural phase transitions involving large density discontinuities, especially those proceeding via a reconstructive mechanism (because the sample turns into a polycrystalline aggregate after the transition). Recent technological developments, such as the COMPRES-GSECARS gas loading system, as well as developments in synchrotron-based high-pressure crystallographic techniques have opened new opportunities to explore the behavior of crystals with much smaller sizes (down to below 1 micrometer) to significantly higher pressures (above 100 GPa) while retaining the main advantages of single-crystal techniques. With the advantage of these new developments long-standing Mineral Physics mysteries, such as the nature of ε−oxygen or CaCO3-III, which puzzled researchers for decades, are starting to be resolved.

Over its long and successful history crystallography-based Mineral Physics established the basic mineral behavior and transformation trends along the room temperature isotherm, as well as the standard mantle geotherm. *In situ* experiments have been focused on studying the equilibrium, stable phases. Structural phase transitions and chemical reactions between the major stable mineral components of the Earth interior have been convincingly linked with the observed seismic velocity discontinuities. At the same time, however, geophysicists gather more and more convincing evidence of additional complexity featuring significant local heterogeneities in composition, temperature and density. Dynamic geologic environments, such as subduction zones can also produce conditions that are quite far from the normal mantle geotherm. All these facts fuel new motivation for exploring metastable regimes of compression and metastable transformations, which are often subtle and structurally complex, posing significant challenges for high-pressure crystallography.



Newport 6-circle circle kappa diffractometer in 13BMC

To meet these challenges and take full advantage of the novel emerging crystallographic methods and technologies, in collaboration with synchrotron experts at GSECARS and the University of Hawaii, COMPRES is supporting the **Partnership for eXtreme Xtallography** (***PX***^{2}), a new forefront experimental facility for high-pressure Mineral Physics research, focused on advanced crystallographic methods. ***PX***^{2} will be located at the Advanced Photon Source experimental station 13BMC, at Argonne National Lab. Among the primary target user base for this new facility are researchers currently conducting

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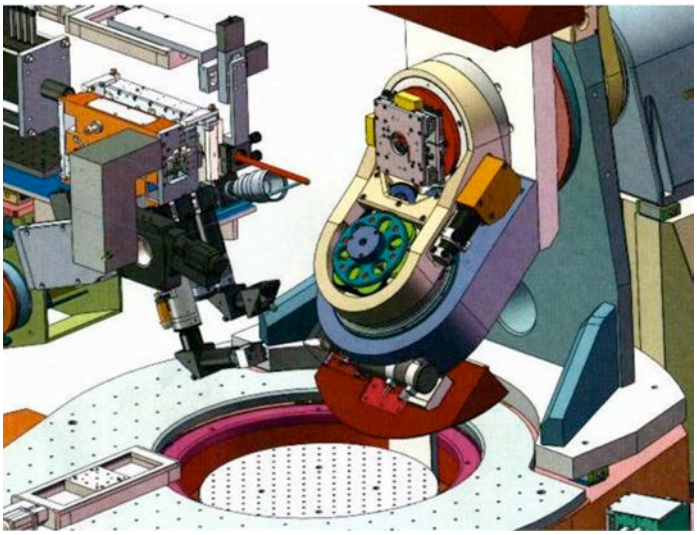
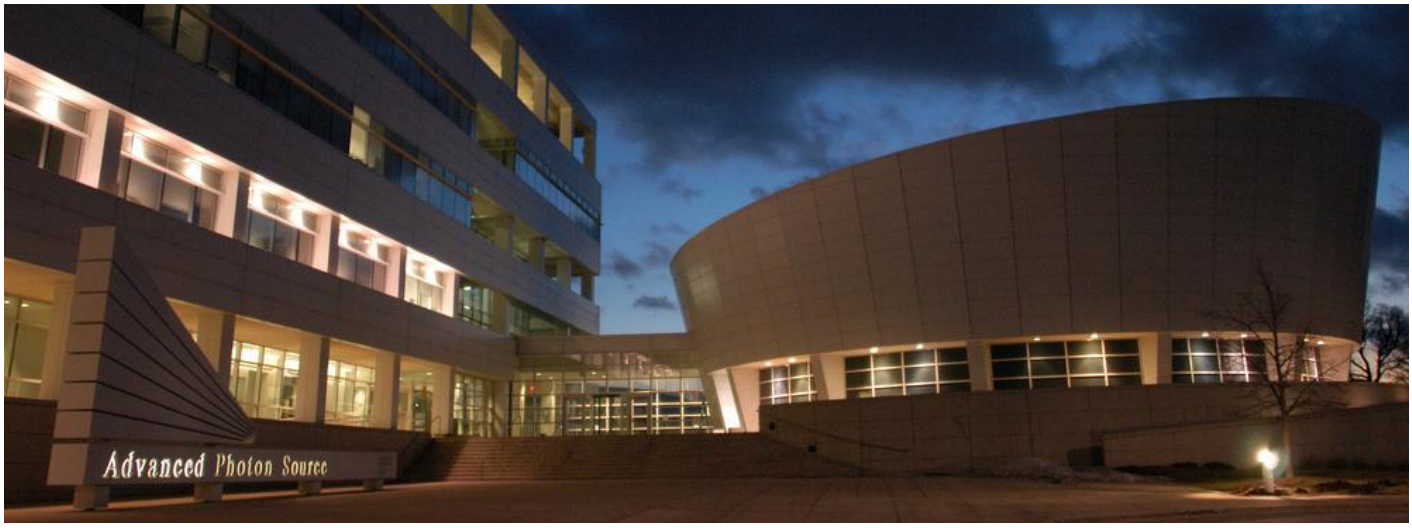
Earth science experiments at the NSLS diamond anvil cell beamlines X17-B3 and X17-C, whose access to beam time will be significantly limited after the planned closure of NSLS in the fall of 2014. ***PX²*** is therefore critical for providing continued access to high-quality facilities for DAC diffraction during the NSLS/NSLS-II "dark period". For diamond anvil cell experiments the 13BMC experimental station will offer a fixed-energy, focused ~30 keV incident beam. The station is equipped with a unique heavy-duty high-precision Newport 6-circle kappa diffractometer (4 circles for sample rotation + 2 circles for detector rotation) that will be outfitted with a state of the art spectroscopic and visual observation system. The Newport diffractometer can be used with a wide range of X-ray detectors, including Pilatus 100K, MAR165 CCD and MAR345 Image Plate and is compatible with all currently used types of diamond anvil cells. The diffractometer offers high speed (up to 15 deg/sec), high load capacity (up to 25 lb), high precision of rotation (sphere of confusion below 10 micrometers) and an exceptional number degrees of freedom for sample and detector manipulation, which will be ideal for advanced crystallography experiments. 13BMC will offer excellent capabilities for conducting high resolution single-crystal and powder diffraction studies in the diamond cell, which are in high demand in the Mineral Physics community. Because of the unique instrumentation, some of the experimental characteristics, including resolution/peak width and angular coverage will be dramatically improved, compared to the current NSLS setup. In addition to the focus on high-resolution powder diffraction technique, the new project will offer currently unmatched performance for single-crystal experiments in diamond anvil cell at high temperature, including data collection during laser heating. The ***PX²*** project at 13BMC will officially start on June 1, 2014, but commissioning efforts are already well underway. The new program is expected to start accepting General User Proposals for the 2014-3 APS run (October-December 2014), for which the application deadline is Friday, July 11, 2014.



3-dimensional drawing of the planned advanced optics for diamond anvil cell experiments

– Przemyslaw Dera

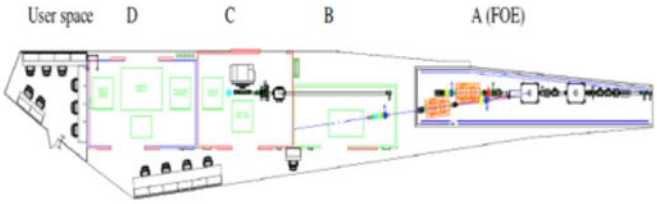


Next Phase of COMPRES Facility at NSLS II

The National Synchrotron Light Source (NSLS) is the home to major COMPRES facilities for *in situ* high pressure research in the Earth Sciences. To meet the critical scientific challenges of different research areas that NSLS current serves, Brookhaven National Laboratory is constructing a new state-of-the-art facility, NSLS-II, designed to deliver world-leading intensity and brightness, and will produce X-rays more than 10,000 times brighter than the current NSLS. The final day of operations at NSLS is scheduled to be September 30, 2014, after which the development of high-pressure beamline facilities at NSLS-II will begin in earnest.

NSLS-II offers unique characteristics in spatial and energy resolution while providing high-flux photons spanning energies from IR range to 100 keV. COMPRES has gained access to XPD (X-ray Powder Diffraction); one of the first six NSLS-II beamlines to be constructed and instrumented. The beamline consists of two branches providing X-rays into three experimental endstations. Two endstations, one on the main branch (Hutch C or D) and one on the side branch (Hutch B), can be operated simultaneously. The high-pressure program will be housed in Hutch D, which will be able to receive beam on day one of NSLS-II operations.

We anticipate that the COMPRES high-pressure program will garner about 30% of the available XPD beamtime. We intend to use this strong Day One foothold as a base to more aggressively push forward proposals for dedicated high pressure facilities that have been approved but not yet funded, such as 4DE[2] (4-Dimensional Studies in Extreme Environments). COMPRES hopes to have both Diamond Anvil Cell (DAC) and Multi-Anvil Cell (MAC) capabilities at XPD. The DAC program will concentrate on medium pressure experiments ($p \leq 1$ Mbar) at high energies in combination with resistive heating and external laser heating. The MAC program will focus on studies of elasticity, anelasticity, rheology, kinetics, and thermal diffusivity for "large volume" samples to 30 GPa and 2500K. The MAC facility will house the first-ever DT25 Kawai-type high pressure system with differential stress capability. This system provides controlled deviatoric stress at higher pressures than ever before. The new state-of-the-art high pressure facilities at NSLS II are poised to produce exciting new research opportunities.



Above – Schematic of XPD with hutch labeling.
Right – Schematic layout of XPD on experimental floor.
Hutch A: Front Optics Enclosure
Hutch B: Total X-ray Scattering
Hutch C: Medium and High-Resolution Powder Diffraction
Hutch D: High Pressure (Multi-Anvil & Diamond Anvil Cell)

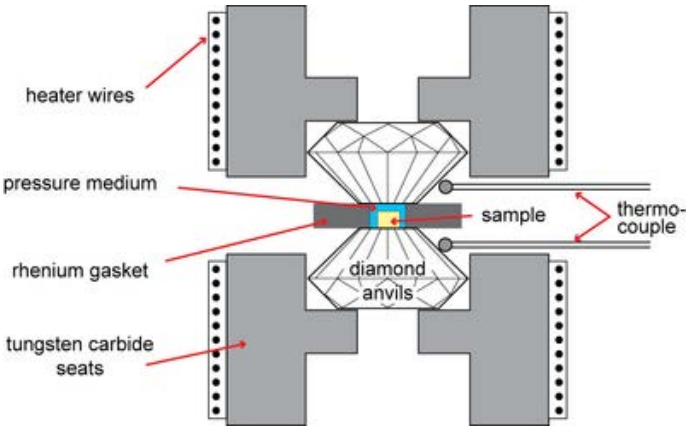
Highlight of COMPRES Staff

Dr. Matthew L. Whitaker

Dr. Whitaker earned his Ph.D. in Geosciences from Stony Brook University in the summer of 2009. After a brief stint as a post-doctoral fellow at the Geodynamics Research Center at Ehime University in Japan, he was hired to the Faculty of Earth Sciences at Ehime University as an Assistant Professor. He left this position and came back to the United States in the summer of 2011, taking on the position of Beamline Scientist with COMPRES and returning to his old home of Stony Brook. Dr. Whitaker is responsible for the X17MAC facility (X17B2 and X17B2ss beamlines plus supporting laboratory facilities) from day-to-day operations and maintenance, to beamtime scheduling, to user education and training, to cell assembly development, stocking, and preparation, to optimizing and designing new experimental protocols. Beamline facility and technique development is also a large part of Matt's responsibilities. His own research interests include *in situ* studies of crustal, mantle, and core minerals at high pressures and temperatures, synthesis of novel and superhard materials, and thermoelasticity and acoustic velocities of materials under extreme conditions. In his free time, Dr. Whitaker is the lead singer in two hard rock/heavy metal bands and is an avid karaoke singer, oftentimes bringing X17MAC users along for the ride. Dr. Whitaker regards his work at X17MAC as, "Stressful but uniquely rewarding. I get to interact with research groups working on a wide variety of problems that otherwise I would not have had the chance to be a part of. On the other side of the coin, it is not uncommon for me to be called in at 3am to solve a problem that has cropped up during an experiment." Despite the late-night phone calls, Dr. Whitaker remains upbeat and optimistic, always willing to help users and attack new problems. "New ideas and new ways to tackle them is what I'm all about – what COMPRES is all about. If you have an idea, bring it and we'll find a way to make it happen!"

Webinar: Mineral Physics 101

Drs. Pamela Burnley and Sylvia-Monique Thomas are once again hosting the COMPRES Graduate Seminar "Mineral Physics 101" during the Spring 2014 semester. The course is meeting via webinar on Mondays from 11:30 – 1:00 PM PST, Jan 27th- May 5th. Although enrollment for the course is now closed, visitors and auditors are always welcome to join. The course is an entry level graduate course in mineral physics that will familiarize students with mineral physics topics and techniques so that they can comfortably read research literature in mineral physics. If you would like to visit or audit the class please write to us at mineralphysics101@gmail.com and we will provide you with a link to attend the webinar. The schedule of topics and lectures including guest lectures can be found at: http:// faculty.unlv.edu/pburnley/COMPRESMP101.html.



New Careers and Education

http://www.compres.us/index.php?option=com_content&task=view&id=198&Itemid=292

As part of their Infrastructure and Development Project *"Mineral Physics on the Web"* Pamela Burnley and Sylvia-Monique Thomas have created a **Careers and Education** section for the COMPRES website. The new section has three parts: **Careers, Education** and **Student Community.** The **Careers** section contains career profiles contributed by a number of members of the COMPRES community, pages listing current openings for graduate students and postdocs as well as other job opportunities. In addition there is information about where mineral physicists work. In the **Education** section there are links to materials from the COMPRES Introduction to Mineral Physics course, and other tutorials, teaching materials and useful applets. The **Student Community** pages include lots of career advice and resources for graduate students, a list of undergraduates who have participated in Mineral Physics research and a place for students and postdocs to post personal profiles to help them with networking. If you are looking for a graduate student or post doc for your program or if you are a student looking for a position, we want this to be the place to go to find what you are looking for. Now that the pages are launched we are actively looking for more information to add. If you have undergraduate researchers working for you who aren't listed, if you have a position announcement for a student, if you are looking for summer REU students, if you have advice or educational materials to share, if you want to contribute a career profile or a student profile, or if you have an idea for other useful materials we can post please contact us at Burnley@physics.unlv.edu or Sylvia-Monique.Thomas@unlv.edu.

– Pam & Sylvia-Monique

Update on Student/Postdoc Community

http://www.compres.us/index.php?option=com_content&task=view&id=196&Itemid=290

In October of this year we began compiling e-mail addresses for the student/postdoc portion of the COMPRES website. Since the initial announcement, 35 student and postdocs have shown interested in participating and have been added to the new COMPRES student/postdoc e-mail list. A short survey was then sent out to the e-mail list requesting information for the individual profiles that are being created as part of the website.

Dr. Sylvia-Monique Thomas and Pamela Burnley have done a great job constructing the student/postdoc portion of the website, and I would encourage everyone to visit the website and see all the progress. The student/postdoc section of the website will be a great opportunity to increase your visibility as a student or postdoc within the community, and will also be very helpful when networking and job hunting. If you are a student or postdoc who is still interested in participating and have not responded to the questionnaire, feel free to answer any or all of the questions below and send your response to Christopher Cline (clinec4@unlv.nevada.edu) in order for your personal profile to be constructed.

Questionnaire:

1) What institution are you currently affiliated with?
2) Who is/are your advisors?
3) A short list or sentence on your research interests:
4) What level of degree are you seeking, or are you a postdoc, proposed completion date of your current position?
5) Link to personal research website:
6) A picture:

– Christopher Cline II
COMPRES student/postdoc committee chair

Highlight of Recent PhDs

Jennifer Girard, Ph.D 2011

Department of Mechanical and Material Engineering, Florida International University, Miami, Florida

Dissertation: Effect of Water on Olivine Single Crystals Deformed under Upper Mantle Conditions

My PhD dissertation focused on the effect of water on high pressure and high temperature deformation of olivine single crystals using a Deformation-DIA press coupled with a synchrotron X-ray beam. This research took the advantage of brilliant high energy synchrotron X-rays, coupled with D-DIA high pressure techniques to study the influence of water, the major volatile in Earth's mantle, on dislocation slip systems of mantle minerals. A single crystal deformation technique was developed at the X17B2 beamline. Deformations were carried out in uniaxial compression along $[110]_c$ and $[011]_c$ crystallographic directions, in order to activate respectively [100](010), [001](010) and [100](001). Talc sleeves about the annulus of the crystals were used as a source of water in the assembly. Stress and specimen strain rates were calculated by *in situ* X-ray diffraction and time-resolved imaging, respectively. The recovered samples were analyzed by TEM to observe deformation microstructures and water content was quantified using FTIR. Significant weakening effects due to the presence of hydroxyl in San Carlos olivine, $(Mg, Fe)_2SiO_4$, have been observed. Studies on olivine indicate that water reduces the pressure where the slip system activity changes. TEM investigations reveal numerous dislocation dipoles in the annihilation process, indicating that the presence of protons might favor the dislocation glide assisted by climbing during the deformation, essential for the annihilation of the dipole.

This may explain the hydrolytic weakening observed in this study. The pressure effect on the activity of the slip system has been quantified and the hydrolytic weakening has also been estimated for both orientations. The weakening factor (σ_{dry} / σ_{wet} at same strain rate) ranges from 3.6 to 1.6 for $[110]_c$ orientation. A stronger hydrolytic weakening has been observed on $[011]_c$ orientation up to factor of 2 bigger. A larger pressure effect was observed on $[110]_c$ orientation, with an activation volume estimated between 12.1 and 17.3 cm^3/mol. Much smaller pressure effect was estimated for $[011]_c$ orientation of about 3±4cm^3/mol.

By direct comparison of single crystal strain rates, we observed that $[110]_c$ deforms faster than $[011]_c$ below 5 GPa. However, above 6 GPa $[011]_c$ deforms faster than $[110]_c$. This indicates that [100](010) is the dominant slip system below 5 GPa, and above 6 GPa [001](010) becomes dominant. According to our results, the slip system transition, which is induced by pressure, occurs at 6 GPa. Water influences the pressure where this switchover occurs by lowering the transition pressure from 8 GPa (corresponding to a depth of 260 km) to 6 GPa (corresponding to 220 km). This result makes the pressure-induced transition of the dominant slip system in olivine a more reasonable candidate for the origin of seismic anisotropy attenuation in the upper mantle. Another significance of this result is that such an effect by water offers an excellent explanation of the depth variation of the attenuation due to the heterogeneity of water distribution in the mantle.

Personal Statement: It has been a great chance to work with my PhD thesis advisor Prof. Jiuhua Chen and my colleagues at Florida International University and at the National Synchrotron Light Source. I was first introduced into the field of experimental mineral physics by Prof Paul Raterron and Prof. Chen during my master thesis obtained in France at UMET at Universite des Sciences et Technologies de Lille. I was fortunate enough to be exposed to high pressure techniques coupled with multiple synchrotron techniques, at an early stage of my studies, which allowed me to developed many skills for high pressure research, that I am intending to use to understand the earth and planetary

(*cont'd*)
interiors. I am currently a post doctoral researcher at Yale University, geology and geophysics department, working with Prof. Shun-Ichiro Karato. My current research interests are focused on the study of the rheology of lower mantle minerals at Yale. According to the seismology data, the majority of the lower mantle appears to be isotropic, even though the major constituents of the lower mantle, $(Mg,Fe)SiO_3$ and (Mg,Fe)O, are highly anisotropic. Studying the deformation of perovskite and MgO mixtures under lower mantle conditions could lead to a better understanding of the dynamics of the lower mantle, and in turn, a better understanding of mantle dynamics in their entirety. In order to accomplish this, I have modified the RDA cell assembly to push the limits of the high pressure device and to reach the lower mantle conditions. I have observed the formation of perovskite in the apparatus, and performed the high pressure deformation experiments on a silicate perovskite and (Mg,Fe)O mixture. In parallel, I have also been conducting experiments using a Kawai press and EPMA techniques to calibrate a geothermometer ($CaSiO_3$+MgO mixture) that is stable under lower mantle conditions. ■■■

Zhongying Mi, PhD 2012

University of Western Ontario, London, Canada

Dissertation: Stress, strain and elasticity study on nacl and nacl-mgo mixture to mantle pressures

Rheological properties of the Earth control most of the important geological processes, such as mantle convection, plate tectonics, earthquakes and the nature of thermal evolution. Most parts of the Earth consist of multi-phases polycrystalline aggregates with various compositions. Therefore, deformation studies on multi-phase materials are important to understand the rheology properties and the dynamics of the Earth. The large contrast in elastic and rheological properties of NaCl and MgO makes them excellent analogue materials for modeling the composite Earth that has both strong and weak minerals. *In situ* high pressure radial X-ray diffraction study using diamond anvil cell were performed at beam line X17C, NSLS, Brookhaven National Laboratory. Four different starting materials, pure NaCl, NaCl-MgO (3:1), NaCl -MgO (2:1) and NaCl-MgO (1:1) mixture, were used in this study and the pressures were conducted at up to 43.7, 57.6, 43.1 and 44.4 GPa, respectively. Phase transformation of pure NaCl from B1 (rock-salt structure) to B2 (CsCl structure) started at 29.8 GPa, and completed at around 32.3 GPa. In the mixture of NaCl- MgO (3:1), NaCl B1 and B2 phase transformation occurred at ~29.4 GPa and finished at around 36.7 GPa. For NaCl-MgO (2:1) mixture, NaCl B1 and B2 phase transformation started at ~30.7 GPa and completed at around 38.8 GPa. In the experiment of NaCl-MgO (1:1) composite, phase transition from B1 to B2 started at ~33.1 GPa, and B1 remained observable to the maximum pressure of 44.4 GPa. It is therefore noted that the involvement of strong materials (MgO) may extend the stability of NaCl B1 phase to much higher pressure. The differential stresses (lower bound of yield strength) of NaCl B1 phase increase gently with pressure, suggests that NaCl B1 is a good pressure-transmitting medium at pressure below 30 GPa. The differential stresses supported by NaCl B2 phase become abruptly increase and is no longer regarded as "soft" pressure. Based on peak broadening study, the deformation of NaCl B1 remains in elastic regime, whereas B2 phase undergoes a plastic deformation instead. The elastic constants of B1 phase calculated by lattice strain theory show reasonable agreement with previous reports

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(*cont'd*)
to 27 GPa, as above 27 GPa NaCl is subject to plastic deformation. Differential stresses supported by different planes show that B1 200 has the lowest value, suggesting B1 200 may be responsible for the initial deformation under pressure. Generally, strength of NaCl in (3:1) mixture is 65-75% higher than that of pure NaCl B1 phase and 45-70% higher for B2 phase. Strength of NaCl in (2:1) composite is 50-120% higher than pure NaCl B1 phase and 90-160% higher than NaCl B2 phase. Strength of NaCl in (1:1) mixture is 15-280% higher than pure NaCl B1 phase and 145-240% higher than NaCl B2 phase. The stresses supported by NaCl in a NaCl-MgO mixture environment are higher than that of pure NaCl. Conversely, the stresses supported by MgO in the NaCl-MgO mixture are lower than that of pure MgO. It can be inferred that in a mixture, strong material could strengthen the "soft" material whereas "soft" material may also be influenced by the strong material.

Personal Statement: I'd like to thank my Ph.D advisor Prof. Sean Shieh and my colleagues at the University of Western Ontario. Dr. Shieh first introduced me into high pressure field with a neatly written notebook, and told me how to be organized, careful and working hard. I benefited a lot by taking clear notes when doing experiments. He trained me with many synchrotron trips and lab facilities, and I am much more skillful on engineering after I finished my study. I am currently a postdoctoral fellow at the Center for High Pressure Science and Technology Advanced Research (HPSTAR) working with Dr. Ho-Kwang Mao and Dr. Bin Chen. My current research interests include the water effect on the strength, compressibility and texture of minerals to mantle pressures; the effect of defect-site stored impurities on the rheology of minerals; physical and chemical properties of nano-materials and so on. I would love to collaborate with the high pressure community by exploring materials in different ways to interpret the large scale geological phenomena.

Introducing MINUTI Software

A new software MINUTI (MINeral physics UTIlities) for scientific applications has been released by Wolfgang Sturhahn. The applications include: calculation and fitting of experimental p-V-(T) data to a thermal (Mie-Grueneisen-Debye) and/or spin equation of state; calculation of sound velocities including spatial averages from elastic constants; calculation and fitting of melting spectra from nuclear resonant forward scattering experiments. MINUTI offers the use of priors in fitting of the data. Improved versions of PHOENIX and CONUSS for evaluating nuclear resonant inelastic scattering and synchrotron Mössbauer spectroscopic data have also been released. Detailed manuals and the link for downloads can be found at www.nrixs.com.

The MINUTI program package is written in Fortran90. It was extensively tested over the past two years and was continuously improved to handle various data input formats and provide useful diagnosis tools for high-quality data evaluation. A graphical display option is standard with the binary versions. MINUTI can been installed on all UNIX-like operating systems, such as Sun's Solaris, Apple's Mac OS X, Redhat-Enterprise Linux, Fedora Linux, Ubuntu, Suse, etc. For MS-Windows like operating systems, a Linux/Unix emulator needs to be installed to run MINUTI.

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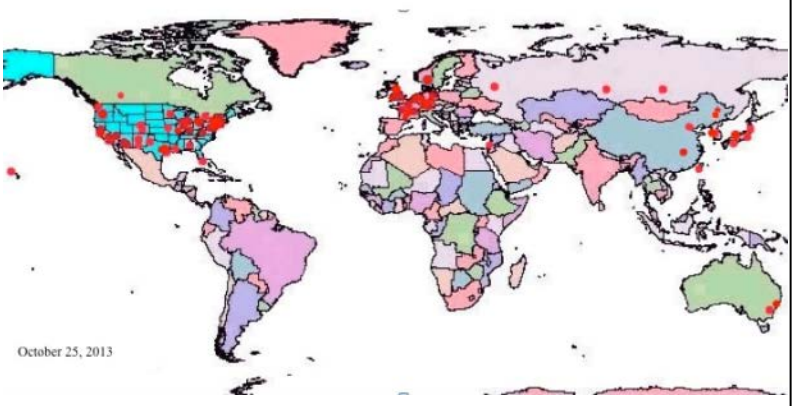

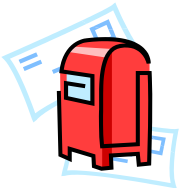

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