**Matthew L. Whitaker**

**COMPRES Beamline Scientist 2014-2015 Annual Report**

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CURRENT POSITIONS:

Beamline Scientist, COMPRES High Pressure Multi-Anvil X-Ray Facilities, NSLS-II & APS;

Research Assistant Professor in Mineral Physics Institute, Stony Brook U. July 1, 2011 – Present

JOB DESCRIPTION:

Responsibilities of the MAC beamline scientist include, but are not limited to, assisting users, managing support laboratories, developing high-pressure synchrotron techniques, and conducting independent research. The position also involves design, testing, and construction of new instrumentation and software development for data acquisition and analysis. This past year has focused primarily on the design, development, construction and commissioning of the new multi-anvil cell facilities at 6-BM-B of APS and XPD-D of NSLS-II. COMPRES support – 100%.

ACTIVITIES:

Design, Development, Construction, and Commissioning of New Beamlines (50%)

* Preparation, brainstorming, and design for 6-BM-B at APS
* Preparation, brainstorming, and design for XPD-D at NSLS-II
* Decommissioning and disassembly of X17MAC facilities at NSLS
* Building experimental system and controls for 6-BM-B at Stony Brook
* Redesign and successful testing of hydraulic systems for 6-BM-B
* Hutch Layout and Equipment Certification (6-BM-B & XPD-D)
* Coordination of Outside Help (6-BM-B & XPD-D)
* Organization of Equipment Transfer and Placement (6-BM-B & XPD-D)
* Building and Outfitting New Computer Control Workstations (6-BM-B & XPD-D)
* Work Planning and Task Management for Beamline Construction (XPD-D)
* Press and equipment load testing and certification (6-BM-B)
* Building and Testing Systems @ Stony Brook (6-BM-B)
* Equipment Assembly and Alignment (6-BM-B)
* Electronics and Network Communications (6-BM-B)
* Redesign of EPICS Controls (6-BM-B)
* Testing of Experimental Equipment (6-BM-B)
* Alignment of Optical and Detector Systems (6-BM-B)
* Redesign and Implementation of Data Acquisition Software (6-BM-B)
* Full Commissioning of the Beamline (6-BM-B)
* Extensive Travel and Long-Distance Support; “The Big Guns” (6-BM-B)

Beamline Development Projects (15%)

* Design and development of new ultrasonic interferometry system
* Full commissioning of integrated acoustic velocity measurement system
* Ultrasonic interferometry data collection and analysis software and techniques
* Upscaling of DTCup concept to new DT-25 deformation Kawai module
* Development of new “high-speed” pressurization protocol for sensitive samples
* Standardization of cell assemblies and calibrations of standardized cells
* Development of synchrotron-based rock mechanics experiments
* Increasing offline (no beam) capabilities and usage
* Design and development of software-automated data collection controls and protocols
* Redesign and fine-tuning of data reduction software (PLOT85)
* Authored several MATLAB scripts for processing and converting experimental data
* Supervising undergraduate thesis work on software development for analyzing stress and strain in monochromatic X-ray diffraction data (Student: Eric Quackenbush)

User Assistance at 6-BM-B (12.5%)

* Beamtime scheduling
* User training (official and unofficial)
* Student training and advising
* Sample preparation
* Experimental preparation
* Experiment design
* Experimental protocol
* Data collection and standardization
* Data reduction
* Data interpretation
* Manuscript assistance

Support Laboratory Management (7.5%) – Includes facilities at NSLS-II, APS, and SBU:

* Experimental Hutch, Equipment, Tech and Prep areas at 6-BM-B
  + Press & Hydraulic Systems Maintenance
  + Beamline Slits and Optics Systems Maintenance
  + Detector Troubleshooting & Maintenance
  + Design, ordering, and inventory of anvils for D-DIA, D-T10 and D-T25
  + Inventory of tools and consumables
* High Pressure Laboratory at Stony Brook University
  + Equipment and materials for making B-epoxy cells
  + Equipment for modification and drilling of cells and parts
  + Thermocouple wires, ceramics, and insulation tubing
  + Staging area for equipment/systems to be transported to 6-BM-B or XPD-D
* Machine Shop Facility at Stony Brook University
  + Designated machine facility supervisor
  + Taking appropriate machine trainings at Brookhaven National Lab
  + Training and supervision of users
  + Limited equipment and facilities until formal inspection

DIA Cell Assembly Development Project (5%) – Joint Project (M. Whitaker / K. Leinenweber)

* Design specifications
* Cost minimization process
* Materials selection
* Ordering and receiving
* Cataloguing and inventory
* Experimental testing
* Stock maintenance
* Distribution to users

Other Responsibilities/Activities (5%) – Including, but not limited to:

* Maintaining records and data mining for COMPRES Beamline Annual Report
* Facility website design, development and maintenance
* User informatics survey
* Graduate student supervision
* Undergraduate Thesis Supervision
* High School Research Advisor – Monroe Woodbury District
* Weekly staff meetings
* This report

Independent Research (5%) - Other responsibilities of position take precedence

* I had given up 21 days of my own beamtime to other users who suffered from Wiggler/ring issues at NSLS, not including my own lost time due to these issues.
* Assigned 6 and 3 days of beamtime at 6-BM-B during 2015-2 and 2015-3 cycles which were used for beamline setup and commissioning – no useful data collected.

SCIENTIFIC PROJECTS (2014-2015):

* Acoustic Velocities and Thermoelastic Properties of Iron/Light-Element Alloys at High Pressure and Temperature (P.I. – Matthew L. Whitaker)
* Acoustic Velocities and Thermoelasticity of Deep Crustal and Mantle Minerals at High Pressure and Temperature (P.I. – Matthew L. Whitaker)
* Relative Pressure and Temperature Efficiencies of DIA Pressure Media (P.I. – Matthew L. Whitaker)
* Time Dependence of Thermal Gradients in Multi-Anvil Experiments (P.I. – Matthew L. Whitaker)
* Acoustic Velocities and Thermoelasticity of Iron-rich Olivines (P.I. – Frederic Bejina & Matthew L. Whitaker)
* DT-25: A new Kawai-style deformation device capable of achieving lower mantle conditions (Weidner/Whitaker)
* Partial Melting at Mantle Conditions: Effect on Elastic, Anelastic, and Plastic Behavior (P.I. – Li Li)
* Compaction of Quartzite at low pressures (P.I. – Donald J. Weidner)
* Equation of State of Iron-rich Olivine (P.I. – Frederic Bejina [with Nicolas Terce, Ph.D. Student])

REFERREED PUBLICATIONS (2014-2015):

Suer, T.-A., Li, L., **Whitaker, M.L.**, and Weidner, D.J. (**submitted**) Olivine Viscoelasticity in Sinusoidal Stress Fields at Mantle Conditions. High Pressure Research.

Dobson, D.P., Hunt, S.A., Ahmed, J., Lord, O.T., Wann, E., Santangeli, J., Wood, I.G., Vocadlo, L., Walker, A., Mueller, H.J., Lathe, C. and **Whitaker, M.L.** (**submitted**) The Phase Diagram of NiSi to 19 GPa and Preliminary Results to 60 GPa. Physics of the Earth and Planetary Interiors.

Hunt, S.A., Weidner, D.J., McCormack, R.J., **Whitaker, M.L.**, Bailey, E., Li, L., Vaughan, M.T., and Dobson, D.P. (**2014**) Deformation T-Cup: A new multi-anvil apparatus for controlled strain-rate deformation experiments at pressures above 18 GPa. Reviews of Scientific Instruments, 85, 085103. DOI 10.1063/1.4891338

Fujino, K., Nishio-Hamane, D., Nagai, T., Seto, Y., Kuwayama, Y., **Whitaker, M.L.**, Ohfuji, H., Shinmei, T., and Irifune, T. (**2014**) Spin Transition, Substitution, and Partitioning of Iron in Lower Mantle Minerals. Physics of the Earth and Planetary Interiors, 228, 186-191. DOI 10.1016/j.pepi.2013.12.008

ABSTRACTS (2014-2015):

**Whitaker, Matthew L.**; Baldwin, Kenneth J.; Huebsch, William B.; Chen, Haiyan; Vaughan, Michael T.; Weidner, Donald J. (**2015**) IDIASCoPE: Directly Integrated Acoustic System Combined with Pressure Experiments COMPRES 2015 Annual Meeting

**Whitaker, Matthew L**.; Chen, Haiyan; Baldwin, Kenneth J.; Huebsch, William B.; Vaughan, Michael T.; Weidner, Donald J. (2**015**) New COMPRES Multi-Anvil Facility at Beamline 6-BM-B of the Advanced Photon Source: Open for Business!

Cheung, Cecilia S. N.; Weidner, Donald J.; Li, Li; Chen, Haiyan; **Whitaker, Matthew L**., (**2015**) Macro and microstress distribution in cold Quartz compression at low and high pressure using synchrotron X-ray diffraction: can we see yielding, failure, grain crushing and pore collapse? COMPRES 2015 Annual Meeting.

**Whitaker, Matthew L**.; Baldwin, Kenneth J.; Huebsch, William B.; Vaughan, Michael T.; Weidner, Donald J. (**2015**) Planned COMPRES Multi-Anvil Facility at Beamline XP-Double-D at NSLS-II

Hunt, S.A., Walker, A.M., Lord, O.T., Stackhouse, S., Armstrong, L.S., Parsons, A.J., Lloyd, G.E., **Whitaker, M.L.** (**2014**) Anelasticity of the HCP metal Zinc: a key to understanding the dynamics of the Earth’s core. Abstract DI31A-4252 at 2014 Fall Meeting, AGU, San Francisco, CA., 15-19 Dec.

**Whitaker, M.L.**, Baldwin, K.J., Huebsch, W.B., Terce, N., Bejina, F., Bystricky, M., Chen, H., Vaughan, M.T., Weidner, D.J. (**2014**) Introducing DIASCoPE: Directly Integrated Acoustic System Combined with Pressure Experiments — Changing the Paradigm from Product to Process. Abstract MR13A-07 at 2014 Fall Meeting, AGU, San Francisco, CA., 15-19 Dec. (Talk)

Cheung, C.S.N., Weidner, D.J., Li, L., Chen, H., **Whitaker, M.L.**, Chen, X. (**2014**) Compaction of quartzite at low pressure using synchrotron X-ray diffraction multi-anvil apparatus. Abstract MR11A-4302 at 2014 Fall Meeting, AGU, San Francisco, CA., 15-19 Dec.

Proietti, A., Bystricky, M., Bejina, F., **Whitaker, M.L.**, Chen, H. (**2014**) Rheology of Olivine and Orthopyroxene at Upper Mantle Conditions. 2014 Réunion des Sciences de la Terre, Pau, France. (in French)

Terce, N., Bejina, F., Bystricky, M., **Whitaker, M.L.**, Chen, H. (**2014**) Elastic Parameters of Fe-rich Olivines. 2014 Réunion des Sciences de la Terre, Pau, France. (in English)

Hunt, S.A., Walker, A.M., Lord, O.T., **Whitaker, M.L.** (**2014**) Analasticity of the HCP Metal Zinc: A Key to Understanding the Dynamics of Earth’s Core. Geological Society Deep Earth 2014 Meeting.

Proietti, A., Bystricky, M., Bejina, F., **Whitaker, M.L.**, Chen, H. (**2014**) Rheology of Olivine and Orthopyroxene at Earth’s Upper Mantle Conditions. 52nd European High Pressure Research Group Meeting, Lyon, France, 7-12 September, 2014.

Terce, N., Bejina, F., Bystricky, M., **Whitaker, M.L.**, Chen, H. (**2014**) Elastic Parameters of Fe-rich Olivines. 52nd European High Pressure Research Group Meeting, Lyon, France, 7-12 September, 2014.

**Whitaker, M.L.**, Baldwin, K.J., Huebsch, W.B. Chen, H., Vaughan, M.T., Weidner, D.J., (**2014**) COMPRES Synchrotron-Based Multi-Anvil Research: Where We Are and Where We Are Going. COMPRES 2014 Annual Meeting. (Talk)

USERS ASSISTED (2014-2015):

Kenneth Baldwin (SBU)

Prederic Bejina (Toulouse)

Pamela Burnley (UNLV)

Michal Bystricky (Toulouse)

Haiyan Chen (SBU)

Cecilia Cheung\* (UW-Madison)

Naveen Dharmagunawardhane\* (SBU)

William Durham (MIT)

Jennifer Girard (Yale)

Gabriel Gwanmesia (Delaware U.)

Caleb Holyoke (TAMU)

William Huebsch (SBU)

Simon Hunt (UCL)

Li Li (SBU)

Arnaud Proietti\* (Toulouse)

Eric Quackenbush (SBU)

Paul Raterron (Lille)

Nicolas Terce\* (Toulouse)

Richard Triplett (SBU)

Michael Vaughan (SBU)

Liping Wang (UNLV)

Donald Weidner (SBU)

*\*denotes student*

USER-FRIENDLY/SOFTWARE DEVELOPMENTS (2014-2015):

* Redesigned, coded, and streamlined user control interface at 6-BM-B
* Created new universal user script for 6-BM-B that can automate large portions of experiments and data collection (w/ Ken Baldwin)
* PLOT85 Data Analysis Software (w/ Ken Baldwin): Added functionality dealing with ultrasonic data, automated data handling, and eliminated many bugs and instabilities
* Generated Python and MATLAB scripts for processing data collected during experiments
* Successfully implemented a method at 6-BM-B for re-centering the beam that shaves hours off of the initial centering and alignment process, and also returns to the proper calibration during an experiment that was tested at X17B2

PROPOSALS (2014-2015):

* Establishing Acoustic Measurements as a User Program at COMPRES MAC Facilities. COMPRES 2016 Infrastructure Development Proposal, $40,000, 1 yr. (Principal Investigator)
* Developing, Testing and Commissioning the New DT-25 Module at XPD-D, NSLS-II. COMPRES 2016 Infrastructure Development Proposal, $70,000, 2 yrs. (Principal Investigator)
* Acoustic Velocities and Thermoelasticity of Olivine at High Pressure and Temperature (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.
* Effect of water on marco and micro stress in quartz compression: does pre-existing water content in quartz play a role? (P.I. – See Nga Cecilia Cheung) APS Beamtime Proposal: 6-BM-B.
* Water content in quartz compression using FTIR: does pre-existing water content in quartz play a role? (P.I. – See Nga Cecilia Cheung) APS Beamtime Proposal: 9-BM-XOR/CMC.
* Determination of Pressure Efficiencies and Thermal Gradients in Standardized Multi-Anvil Cell Assemblies II (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.
* In situ ultrasonic measurements and equations of state of Fe-rich olivine polymorphs (P.I. – Frederic Bejina)
* Commissioning of New Acoustic Velocity Measurement System at 6-BM-B (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B
* NSF-EAR1523996, $410,854, 1-SEP-2015 to 31-AUG-2018, Phase Relations and Thermoelastic Properties of Crustal and Upper Mantle Minerals. Status: Declined (Principal Investigator)
* NSF-EAR1520640, $450,726, 1-JUN-2015 to 31-MAY-2018, The Effect of Iron on Thermoelastic Properties of Olivine and Pyroxene at Mantle Conditions. Status: Declined (Principal Investigator)
* Establishing Acoustic Measurements as a User Program at COMPRES MAC Facilities. COMPRES 2015 Infrastructure Development Proposal, $40,000, 1 yr. Status: Declined (Principal Investigator)
* Developing, Testing and Commissioning the New DT-25 Module at XPD-D, NSLS-II. COMPRES 2015 Infrastructure Development Proposal, $70,000, 2 yrs. Status: Declined (Principal Investigator)
* Enhanced High Pressure Synthesis of Fully Dense Bulk Nanostructures. White Paper Response to Solicitation DE-FOA-0000995, DOE-BES 2014. Status: Declined (Co-Investigator)
* In situ Measurement of Acoustic Velocities and Thermoelastic Properties of Iron/Light-Element Alloys at High Pressures and Temperatures (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.
* Acoustic Velocities and Thermoelasticity of Deep Crustal and Mantle Minerals at High Pressure and Temperature (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.
* Determination of Pressure Efficiencies and Thermal Gradients in Standardized Multi-Anvil Cell Assemblies (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.

EDUCATION, OUTREACH, & WORKSHOPS (2013-2014):

* Research Mentor, Intel High School Science Research Program – Summer 2015
* Large Multi Anvil Press Facility Workshop – July 2015
* Nuclear Resonant Scattering and Data Analysis Workshop – November 2014
* Future Directions in Mineral Physics Workshop – October 2014