

# **Matthew L. Whitaker**

## **COMPRES Beamline Scientist 2015-2016 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

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### **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 continued development and maintenance of the multi-anvil facility at 6-BM-B of APS and the design, development, and construction of the new multi-anvil cell facility at XPD-D of NSLS-II. COMPRES support – 100%.

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### **ACTIVITIES:**

Design, Development, Construction, and Commissioning of XPD-D Multi-Anvil Facility (50%)

- Preparation, brainstorming, and design for XPD-D at NSLS-II
- Hutch layout and equipment certification
- Redesigning experimental system and controls for equipment
- Redesign and future testing of hydraulic systems
- Coordination of outside help
- Leveraging Brookhaven human and capital resources
- Organization of equipment transfer and placement
- Building and outfitting new computer control workstations
- Work planning and task management for beamline construction
- Assisting with building and testing new motorized control systems @ Stony Brook
- Equipment assembly and alignment
- Electronics and network communications
- Redesign and rescoping of new EPICS controls in CSS
- Testing of experimental equipment
- Preparing for alignment of optical and detector systems
- Design, ordering, and inventory of anvils for D-DIA and DT-25
- Oversight of regular meetings between Stony Brook and NSLS-II staff
- Coordinating efforts for first technical commissioning beamtime at XPD-D
- Preparation of equipment and materials for first science commissioning experiments

#### User Assistance and Technical Support at 6-BM-B (20%)

- Continued development of techniques and facilities
- Redesign and implementation of data acquisition and analysis software
- 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 and interpretation
- Manuscript assistance
- Press & hydraulic systems maintenance
- Beamline slits and optics systems maintenance
- Detector troubleshooting & maintenance
- Acoustic velocity measurement system operation, troubleshooting, and maintenance
- Design, ordering, and inventory of anvils for D-DIA
- Extensive Travel and Long-Distance Support; “The Big Guns”

#### Beamline Development Projects (15%)

- Continued development of integrated acoustic velocity measurement system, 6-BM-B
- Adaptation of acoustic velocity measurement system to DT-25 at XPD-D
- Ultrasonic interferometry data collection and analysis software and techniques
- Upscaling of DTCup concept to new DT-25 deformation Kawai module
- Development of new super-fast heating protocol for rapid heating of samples in ~1 s
- Standardization of cell assemblies and calibrations of standardized cells
- Design and development of software-automated data collection controls and protocols
- Redesign and fine-tuning of data reduction software (PLOT85)
- Transferring data analysis and experiment control protocols to Python for XPD-D
- Authored several MATLAB scripts for processing and converting experimental data
- Supervising undergraduate research on software development for analyzing stress and strain in monochromatic X-ray diffraction data (Student: Eric Quackenbush)

#### 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

#### Independent Research (5%) - Other responsibilities of position traditionally taken precedence

- Majority of beamtime at 6-BM-B used for beamline development and maintenance

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

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

#### SCIENTIFIC PROJECTS (2015-2016):

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- ❖ Acoustic Velocities and Thermoelastic Properties of Iron/Light-Element Alloys 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)
- ❖ Ca-rich Plagioclase at Extreme Conditions: A Case Study of the Formation of Tissintite (P.I. – Melinda Rucks, Ph.D. Student & Matthew L. Whitaker)
- ❖ Acoustic Velocities and Thermoelasticity of Iron-rich Olivines (P.I. – Frederic Bejina & Matthew L. Whitaker)
- ❖ Equation of State of Iron-rich Olivine (P.I. – Frederic Bejina [with Nicolas Terce, Ph.D. Student])
- ❖ Partial Melting at Mantle Conditions: Effect on Elastic, Anelastic, and Plastic Behavior (P.I. – Donald J. Weidner)
- ❖ Acoustic Velocity Measurements Across the Pv-PPv Phase Boundary in Neighborite (P.I. – Li Li)
- ❖ Ultrasonic Velocities in Non-recoverable Perovskite-structured Minerals at High P and T (P.I. – Richard Triplett, Ph.D. Student)
- ❖ Relative Rheology of Transition Zone Minerals and Their Analogues (P.I. – Simon Hunt)
- ❖ DT-25: A new Kawai-style deformation device capable of achieving lower mantle conditions (Weidner/Vaughan/Whitaker)

#### REFERREED PUBLICATIONS (2015-2016):

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Cheung, C.S.N., Weidner, D.J., Li, L., Meredith, P.G., Chen, H., **Whitaker, M.L.**, and Chen, X. (**submitted**) Stress Distribution During Cold Compression of a Quartz Aggregate Using Synchrotron X-Ray Diffraction: Observed Yielding, Damage and Grain Crushing. *Journal of Geophysical Research: Solid Earth*.

**Whitaker, M.L.**, Baldwin, K.J., and Huebsch, W.R. (**acc. w/ rev.**) DIASCoPE: Directly Integrated Acoustic System Combined with Pressure Experiments – A new method for fast acoustic velocity measurements at high pressure. *Reviews of Scientific Instruments*.

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., **Whitaker, M.L.**, Morard, G., and Mezouar, M. (**in press**) The Phase Diagram of NiSi Under the Conditions of Small Planetary Interiors. *Physics of the Earth and Planetary Interiors*.

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*.

## ABSTRACTS (2015-2016):

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**Whitaker, M.L.**, Baldwin, K.J., and Huebsch, W.R., (2016) A New Method for Fast Acoustic Velocity Measurements at High Pressure – Changing the Paradigm from Product to Process. Abstract MR12A-04 at 2016 Fall Meeting, AGU, San Francisco, CA., 12-16 Dec. (Talk)

Li, L., **Whitaker, M.L.**, Triplett, R., and Weidner, D.J., (2016) Acoustic Velocities Across the Perovskite Phase Transition in NaMgF<sub>3</sub>. Abstract at 2016 Fall Meeting, AGU, San Francisco, CA., 12-16 Dec.

Weidner, D.J., Li, L., **Whitaker, M.L.**, and Triplett, R. (2016) P Wave and S Wave Acoustic Velocities of Partial Molten Peridotite at Mantle P-T and MHz Frequencies. Abstract at 2016 Fall Meeting, AGU, San Francisco, CA., 12-16 Dec.

Hunt, S.A., Dobson, D.P., Bailey, E., Ezad, I., Schardong, L., Pamato, M.G., Thomson, A., Walker, A., **Whitaker, M.L.**, and Weidner, D.J. (2016) The Effect of Sintering Pressure on the Anelastic Properties of Pyrope. Abstract at 2016 Fall Meeting, AGU, San Francisco, CA., 12-16 Dec.

Terce, N., Bejina, F., Bystricky, M., **Whitaker, M.L.**, Chen, H. (2016) Bulk Modulus of Fe-rich Olivines. 54<sup>th</sup> European High Pressure Research Group Meeting, Bayreuth, Germany, 4-9 September, 2016.

**Whitaker, M.L.**, Chen, H., Baldwin, K.J., Huebsch, W.R., Vaughan, M.T., Weidner, D.J., (2016) Six-BoMB: COMPRES Multi-Anvil Facility at Beamline 6-BM-B of the Advanced Photon Source. COMPRES 2016 Annual Meeting. (Talk)

**Whitaker, M.L.**, Baldwin, K.J., Huebsch, W.R., Vaughan, M.T., Weidner, D.J., (2016) XP-Deuce: Planned COMPRES Multi-Anvil Facility at Beamline XPD-D at NSLS-II. COMPRES 2016 Annual Meeting. (Talk)

**Whitaker, M.L.**, Chen, H., Baldwin, K.J., Huebsch, W.R., Vaughan, M.T., Weidner, D.J., (2015) New COMPRES Multi-Anvil Facility at Beamline 6-BM-B of the Advanced Photon Source: Open for Business! COMPRES 2015 Annual Meeting. (Talk)

**Whitaker, M.L.**, Baldwin, K.J., Huebsch, W.R., Chen, H., Vaughan, M.T., Weidner, D.J., (2015) DIASCoPE: Directly Integrated Acoustic System Combined with Pressure Experiments. COMPRES 2015 Annual Meeting.

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, M.L.**, Baldwin, K.J., Huebsch, W.R., Vaughan, M.T., Weidner, D.J., (2015) Planned COMPRES Multi-Anvil Facility at Beamline XP-Double-D at NSLS-II. COMPRES 2015 Annual Meeting.

## USERS ASSISTED (2015-2016):

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Kenneth Baldwin (SBU)  
Prederic Bejina (Toulouse)  
Pamela Burnley (UNLV)  
Haiyan Chen (SBU)  
Cecilia Cheung (UW-Madison)  
Naveen Dharmagunawardhane\* (SBU)  
William Durham (MIT)  
Jennifer Girard (Yale)  
William Huebsch (SBU)  
Simon Hunt (UCL)  
Li Li (SBU)

Shenghua Mei (UMN)  
Martha Pamato (UCL)  
Eric Quackenbush\* (SBU)  
Melinda Rucks\* (SBU)  
Nicolas Terce\* (Toulouse)  
Andrew Thomson (UCL)  
Richard Triplett\* (SBU)  
Michael Vaughan (SBU)  
Liping Wang (UNLV)  
Donald Weidner (SBU)  
*\*denotes student*

#### USER-FRIENDLY/SOFTWARE DEVELOPMENTS (2015-2016):

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- ❖ Redesigned, coded, and streamlined user control interface at 6-BM-B
- ❖ Created and implemented 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 (2015-2016):

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- ❖ Re-examining in situ Pressure Markers Using Ultrasonics: A Standardless Approach (P.I. – Matthew L. Whitaker) APS Beamtime Proposal
- ❖ Expanding the Available Pressure Range Attainable at 6-BM-B (P.I. – Matthew L. Whitaker) APS Beamtime Proposal
- ❖ 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.
- ❖ Deep-Earth Large-Volume Experimentation. Co-P.I. COMPRES 2017 Infrastructure Development Proposal, \$42,000, 2 yr. Status: Accepted (P.I. – Yanbin Wang)
- ❖ Acoustic Velocities and Thermoelasticity of Olivine at High Pressure and Temperature (P.I. – Matthew L. Whitaker) APS Beamtime Proposal: 6-BM-B.
- ❖ Establishing Acoustic Measurements as a User Program at COMPRES MAC Facilities. COMPRES 2016 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 2016 Infrastructure Development Proposal, \$70,000, 2 yrs. Status: Declined (Principal Investigator)
- ❖ Effect of water on macro 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.
- ❖ 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.
- ❖ 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)

#### EDUCATION, OUTREACH, & WORKSHOPS (2015-2016):

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- ❖ High Pressure Multigrain Crystallography Workshop – October 2016
- ❖ Brookhaven Linear Accelerator Irradiation Workshop – September 2016
- ❖ Monroe-Woodbury High School Science Research Symposium Keynote – May 19, 2016
- ❖ Research Mentor, Intel High School Science Research Program –2015 – Present
- ❖ Large Multi Anvil Press Facility Workshop – July 2015