

# S.-H. Dan Shim | Curriculum Vitae

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## Degrees

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**2001: Ph.D. Geosciences**, Princeton University, Princeton, New Jersey, USA.

Thesis Adviser: Dr. Thomas S. Duffy

**1994: M.S. Geological Sciences**, Seoul National University, Seoul, Korea.

Thesis Adviser: Drs Soo Jin Kim and Jung Ho Ahn

**1992: B.S. Geological Sciences**, Seoul National University, Seoul, Korea.

## Academic Appointments

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**2022–: Navrotsky Professor of Materials Research**, College of Liberal Arts and Sciences, Arizona State University, USA.

**2021–: Professor**, School of Earth and Space Exploration, Arizona State University, USA.

**2012–2021: Associate Professor**, School of Earth and Space Exploration, Arizona State University, USA.

**2015–: Honors Faculty**, Barrett Honors College, USA.

**2019: Visiting Professor**, Yonsei Frontier Lab program, Yonsei University, Seoul, Korea.

**2014: Visiting Researcher**, Institut de Physique du Globe de Paris (IPGP), Paris, France.

**2008–2011: Associate Professor of Experimental Geophysics**, Massachusetts Institute of Technology, USA.

**2003–2008: Assistant Professor of Experimental Geophysics**, Massachusetts Institute of Technology, USA.

**2001–2003: Miller Research Fellow**, University of California at Berkeley, USA.

## Research Interests

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Mineralogy of exoplanets. Structure and dynamics of the deep planetary interiors. Magma ocean and early evolution of planets. Hydrogen storage and transport in the deep mantles and the cores of planets. Structure and dynamics of exoplanets (super-Earths, sub-Neptunes, gas giants, and waterworlds). Materials behavior during planet formation. In situ measurements of crystal structures, chemical reactions, equations of states, and physical properties in diamond-anvil cell using synchrotron X-ray techniques. Application of X-ray free electron laser techniques for high pressure research. Development of new materials at high pressures and high temperatures. Hydrogen storage in materials with naturally abundant elements.

## Honors

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**2022:** Navrotsky Professorship, Arizona State University

**2017:** Nomination for the College of Liberal Arts and Sciences Zebulon Pearce Distinguished Teaching Award, Arizona State University

**2010:** Doornbos Memorial Prize, Studies of the Earth's Deep Interior, International Union of Geodesy and Geophysics (IUGG)

**2004:** Jephtha H. and Emily V. Wade Award, Massachusetts Institute of Technology

**2001–2003:** Miller Research Fellowship, University of California, Berkeley

**2001:** Graduate Research Award, Mineral and Rock Physics Section, American Geophysical Union (AGU)

**2000:** Outstanding Student Paper Award, Tectonophysics Section, American Geophysical Union (AGU)

**2000–2001:** Charlotte Elizabeth Procter Fellowship, Princeton University

**1999–2000:** Research Board Tuition Award, Princeton University

**1999:** Travel Grant, Association of Princeton Graduate Alumni, Princeton University

**1996:** Hess Fellowship, Department of Geosciences, Princeton University

**1992:** Top-Honors Graduate, College of Natural Sciences, Seoul National University

## Professional Network

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**GoogleScholar:** Shim's records on publication and citations [↗](#)

**ORCID:** Shim's research digital identifier, 0000-0001-5203-6038 [↗](#)

**Github:** Shim's open source code and software repository [↗](#)

**ResearchGate:** Shim's publication list with pre-, re-, and post-prints [↗](#)

## Membership

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American Astronomical Society

American Geophysical Union

Mineralogical Society of America

## Recent Research Collaborations (2019–2022)

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**ASU:** E. Garnero and M. Li (structure of the mantle), K. Leinenweber, T. Sharp, D. Smith, and A. Navrotsky (multi-anvil press), P. Buseck (electron microscopy), A. Anbar (geophysics of Archean), S. Desch and P. Young (exoplanets), A. Chizmeshya (density functional theory), J. O'Rourke (Mars interior)

**US:** E. Alp (Advanced Photon Source), M. Kunz (Advanced Light Source), W. Mao and A. Gleason (Stanford University), V. B. Prakapenka (GSECARS, University of Chicago), D. Stegman (University of California, San Diego)

**International:** L. Bindi (University of Florence, Italy), Y. J. Lee (Yonsei University, Korea), G. Morard (Université Grenoble Alpes, France), A. Rivasio (Sorbonne Université, France), S. Speziale (GeoForschungsZentrum Potsdam, Germany)

## Technical Skills

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Laser-heated diamond-anvil cell and multi-anvil press

X-ray diffraction and crystal structure refinement

Dispersive- and gated-Raman spectroscopy

Transmission electron microscopy

Synchrotron X-ray diffraction and spectroscopy: Advanced Photon Source (Argonne National Laboratory), Advanced Light Source (Lawrence Berkeley National Laboratory), National Synchrotron Light Source (Brookhaven National Laboratory), Cornell High Energy Synchrotron Source (Cornell University), and Stanford Synchrotron Radiation Laboratory (Stanford University)

X-ray Free Electron Laser: Linac Coherent Light Source (LCLS) at Stanford Linear Accelerator Center (SLAC) National Accelerator Laboratory, and Pohang Accelerator Laboratory X-ray Free Electron Laser (PAL-XFEL)













Computer programming with Python, FORTRAN, IDL, and C languages and Jupyter in UNIX, Linux, Windows, and Mac OS X systems



1. **T. Kim**<sup>VGs</sup>, S. Chariton, V. Prakapenka, **S.-H. Shim**<sup>CPi</sup>, and Y. Lee. Melting of the hydrated mantle.

## Published Articles




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85. **S. Fu**<sup>PD</sup>, S. Chariton, V. B. Prakapenka, A. Chizmeshya, and **S.-H. Shim**<sup>PI</sup>. Hydrogen solubility in FeSi alloy phases at high pressures and temperatures. *American Mineralogist*, DOI: 10.2138/am-2022-8295 [↗](#), 2022.  
84. **B. Ko**<sup>GS</sup>, E. Greenberg, V. Prakapenka, E. Alp, W. Bi, Y. Meng, D. Zhang, and **S.-H. Shim**<sup>PI</sup>. Calcium dissolution in bridgmanite in the Earth's deep mantle. *Nature*, DOI: 10.1038/s41586-022-05237-4 [↗](#), 2022.  
*Press release: ASU News* [↗](#), *Phys.org* [↗](#)
83. **B. Ko**<sup>GS</sup>, S. Chariton, V. Prakapenka, B. Chen, E. J. Garnero, M. Li, and **S.-H. Shim**<sup>PI</sup>. Water-induced diamond formation at Earth's core-mantle boundary. *Geophysical Research Letters*, DOI: 10.1029/2022GL098271 [↗](#), 2022.  
*Press release: ASU News* [↗](#), *Newsweek* [↗](#)
82. **S. Fu**<sup>PD</sup>, S. Chariton, V. B. Prakapenka, A. Chizmeshya, and **S.-H. Shim**<sup>PI</sup>. A new hexagonal ternary alloy phase stable in Fe-Si-H at 28.6–42.2 GPa and 3000 K. *Physical Review B*, DOI: 10.1103/PhysRevB.105.104111 [↗](#), 2022.  
81. **S.-H. Shim**<sup>PI</sup>, A. Chizmeshya, and K. Leinenweber. Water in the crystal structure of CaSiO<sub>3</sub> perovskite. *American Mineralogist*, DOI: 10.2138/am-2022-8009 [↗](#), 2022. 
80. **H. Piet**<sup>PD</sup>, A. V. G. Chizmeshya, B. Chen, S. Chariton, E. Greenberg, V. B. Prakapenka, P. R. Buseck, **S.-H. Shim**<sup>PI</sup>. Effect of nickel on the high-pressure phases in Fe–H. *Physical Review B*, DOI: 10.1103/PhysRevB.104.224106 [↗](#), 2021. 
79. **H. Piet**<sup>PD</sup>, K. Leinenweber, E. Greenberg, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. Effects of hydrogen on the phase relations in Fe–FeS at pressures of Mars-sized bodies. *Journal of Geophysical Research - Planet*, DOI: 10.1029/2021JE006942 [↗](#), 2021. 
78. **T. Kim**<sup>VGs</sup>, S. Chariton, V. Prakapenka, A. Pakhomova, H.-P. Liermann, Z. Liu, S. Speziale, **S.-H. Shim**<sup>CPi</sup>, and Y. Lee. Atomic scale mixing between MgO and H<sub>2</sub>O in the deep interiors of water-rich planets. *Nature Astronomy*, DOI: 10.1038/s41550-021-01368-2 [↗](#), 2021.  
*Press release: Salon* [↗](#), *ASU* [↗](#), *Nature Astronomy News and Views* [↗](#) . 
77. R. J. Husband, R. S. McWilliams, E. J. Pace, A. L. Coleman, H. Hwang, J. Choi, **T. Kim**<sup>VGs</sup>, G. Hwang, O. B. Ball, S. H. Chun, D. Nam, S. Kim, H. Cynn, V. B. Prakapenka, **S.-H. Shim**, S. Toleikis, M. I. McMahan, Y. Lee, and H.-P. Liermann. X-ray laser heating of water with gold at high static pressure. *Communications Materials*, DOI: 10.1038/s43246-021-00158-7 [↗](#), 2021.  
76. **T. Kim**<sup>VGs</sup>, **B. Ko**<sup>GS</sup>, E. Greenberg, V. B. Prakapenka, **S.-H. Shim**<sup>CPi</sup>, and Y. Lee. Low melting temperature of anhydrous mantle materials at the core-mantle boundary. *Geophysical Research Letters*, DOI: 10.1029/2020GL089345 [↗](#), 2020.
75. **H. Chen**<sup>GS</sup>, S.-Y. Xie, **B. Ko**<sup>GS</sup>, **T. Kim**<sup>VGs</sup>, **C. Nisr**<sup>PD</sup>, V. B. Prakapenka, E. Greenberg, D. Zhang, W. Bi, E. Alp, Y. Lee, and **S.-H. Shim**<sup>PI</sup>. A new iron hydroxide phase stable in hydrous lower-mantle systems. *Earth and Planetary Science Letters*, DOI: 10.1016/j.epsl.2020.116551 [↗](#), 2020. 
74. **H. Allen-Sutter**<sup>GS</sup>, E. Garhart, K. Leinenweber, V. B. Prakapenka, E. Greenburg, and **S.-H. Shim**<sup>PI</sup>. Oxidation of the interiors of carbide exoplanets. *Planetary Science Journal*, DOI: 10.3847/PSJ/ 

abaa3e [↗](#), 2020.

Press release: [CNN](#) [↗](#), Pre-print is available at [arXiv:2005.03175](#) [↗](#).

73. **C. Nisr**<sup>PD</sup>, **H. Chen**<sup>GS</sup>, K. Leinenweber, A. V. G. Chizmeshya, V. B. Prakapenka, C. Prescher, S. Tkachev, Y. Meng, Z. Liu, and **S.-H. Shim**<sup>PI</sup>. Large H<sub>2</sub>O solubility in dense silica and its implications for the interiors of water-rich planets. *Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.1917448117 [↗](#), 2020.  
Press release: *Selected for Media Highlight by PNAS, ASU Now* [↗](#), *Advanced Photon Source Science Highlights* [↗](#), *Phys.org* [↗](#), Argonne National Laboratory Press Release [↗](#)
72. J.-A. Hernandez, G. Morard, M. Guarguaglini, R. Alonso-Mori, A. Benuzzi-Mounaix, R. Bolis, G. Fiquet, E. Galtier, A. E. Gleason, S. Glenzer, F. Guyot, **B. Ko**<sup>GS</sup>, H. J. Lee, W. L. Mao, B. Nagler, N. Ozaki, A. K. Schuster, **S.-H. Shim**, T. Vinci, and A. Ravasio. Direct observation of shock-induced amorphization of enstatite. *Geophysical Research Letters*, DOI: 10.1073/pnas.1920470117 [↗](#), 2020.
71. C. M. Lisse, S. J. Desch, C. T. Unterborn, S. R. Kane, P. R. Young, H. E. Hartnett, N. R. Hinkel, **S.-H. Shim**, E. E. Mamajek, and N. R. Izenberg. A geologically robust procedure for observing rocky exoplanets to maximize the likelihood that atmospheric oxygen is an Earth-Like biosignature. *Astrophysical Journal Letters*, DOI: 10.3847/2041-8213/ab9b91 [↗](#), 2020.
70. H. Li, Y. Qin, **B. Ko**<sup>GS</sup>, D. B. Trivedi, Y. M. Sayad, L. Liu, **S.-H. Shim**, H. Zhuang, and S. Tongay. Anomalous behavior of 2D Janus monolayers under extreme pressures. *Advanced Materials*, DOI: 10.1002/adma.202002401 [↗](#), 2020.
69. G. Morard, J.-A. Hernandez, M. Guarguaglini, R. Bolis, A. Benuzzi-Mounaix, T. Vinci, G. Fiquet, M. A. Baron, **S.-H. Shim**, **B. Ko**<sup>GS</sup>, A. E. Gleason, W. L. Mao, R. Alonso-Mori, H. J. Lee, B. Nagler, E. Galtier, D. Sokaras, S. Glenzer, D. Andrault, G. Garbarino, M. Mezouar, A. Schuster, and A. Ravasio. In situ X-ray diffraction of silicate liquids and glasses under dynamic and static compression to megabar pressures. *Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.1920470117 [↗](#), 2020.
68. H. Hwang, E. Galtier, H. Cynn, I. Eom, S. H. Chun, Y. Bang, G. C. Hwang, J. Choi, **T. Kim**<sup>VG</sup>, M. Kong, S. Kwon, K. Kang, H. J. Lee, C. Park, J.-I. Lee, Y. Lee, W. Yang, **S.-H. Shim**, T. Vogt, S. Kim, J. Park, S. Kim, D. Nam, J. H. Lee, H. Hyun, M. Kim, T.-Y. Koo, C.-C. Kao, T. Sekine, and Y. Lee. Sub-nanosecond phase transition dynamics in laser-shocked iron. *Science Advances*, DOI: 10.1126/sciadv.aaz5132 [↗](#), 2020.
67. **H. Piet**<sup>PD</sup>, K. Leinenweber, **J. Tappan**<sup>UG</sup>, E. Greenberg, V. B. Prakapenka, P. R. Buseck, and **S.-H. Shim**<sup>PI</sup>. Dehydration of  $\delta$ -AlOOH in Earth's deep lower mantle: Implications for the deep hydrogen and oxygen cycles. *Minerals*, 10, 384, DOI: 10.3390/min10040384 [↗](#), 2020.
66. **H. Chen**<sup>GS</sup>, K. Leinenweber, V. B. Prakapenka, M. Kunz, H. Bechtel, Z. Liu, and **S.-H. Shim**<sup>PI</sup>. Phase transformation of hydrous ringwoodite to the lower-mantle phases and the formation of dense hydrous silica. *American Mineralogist*, DOI: 10.2138/am-2020-7261 [↗](#), 2020.
65. **B. Ko**<sup>GS</sup>, V. B. Prakapenka, M. Kunz, C. Prescher, K. Leinenweber, and **S.-H. Shim**<sup>PI</sup>. Mineralogy and density of Archean volcanic crust in the mantle transition zone. *Physics of the Earth and Planetary Interiors*, DOI: 10.1016/j.pepi.2020.106490 [↗](#), 2020.
64. L. Bindi, **S.-H. Shim**, T. Sharp, and X. Xie. Evidence for the charge disproportionation of iron in extraterrestrial bridgmanite. *Science Advances*, 6, eaay7893, DOI: 10.1126/sciadv.aay7893 [↗](#), 2020.  
Press release: *National Science Foundation Research News* [↗](#), *ASU Now* [↗](#)

63. **B. L. Kulka**<sup>UG</sup>, **J. Dolinski**<sup>UG</sup>, K. Leinenweber, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. The bridgmanite–akimotoite–majorite triple point determined in large volume press and laser-heated diamond anvil cell. *Minerals*, 10, 67, DOI: 10.3390/min10010067 [↗](#), 2020.
62. **H. Chen**<sup>GS</sup>, K. Leinenweber, V. B. Prakapenka, C. Prescher, Y. Meng, H. Bechtel, M. Kunz, and **S.-H. Shim**<sup>PI</sup>. Possible H<sub>2</sub>O storage in the crystal structure of CaSiO<sub>3</sub> perovskite. *Physics of the Earth and Planetary Interiors*, 299, 106412, DOI: 10.1016/j.pepi.2019.106412 [↗](#), 2019.  
*Press release: Advanced Light Source Science Briefs* [↗](#)
61. **J. G. O'Rourke**<sup>PD</sup> and **S.-H. Shim**. Hydrogenation of the Martian core by hydrated mantle minerals with implications for the early dynamo. *Journal of Geophysical Research - Planets*, 124, 3422–3441, DOI: 10.1029/2019JE005950 [↗](#), 2019. 
60. **H. Chen**<sup>GS</sup>, S. Zhou, D. Morgan, V. B. Prakapenka, E. Greenberg, K. Leinenweber, and **S.-H. Shim**<sup>PI</sup>. The O–O bonding and hydrogen storage in the pyrite-type PtO<sub>2</sub>. *Inorganic chemistry*, 58, 8300–8307, DOI: 10.1021/acs.inorgchem.9b00046 [↗](#), 2019. 
59. **Y. Ye**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, and Y. Meng. Equation of state of solid Ne inter-calibrated with the MgO, Au, Pt, NaCl-B2, and ruby pressure scales up to 130 GPa. *High Pressure Research*, 38, 377–395, DOI: 10.1080/08957959.2018.1493477 [↗](#), 2018.
58. **H. Chen**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, V. B. Prakapenka, Y. Meng, and C. Prescher. Crystal Structure of CaSiO<sub>3</sub> perovskite at 28–62 GPa and 300 K under quasi-hydrostatic stress conditions. *American Mineralogist*, 103, 462–468, DOI: 10.2138/am-2018-6087 [↗](#), 2018.
57. **C. Nisr**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, and K. Leinenweber. Raman spectroscopy of water-rich stishovite and dense high-pressure silica up to 55 GPa. *American Mineralogist*, 102, 2180–2189, DOI: 10.2138/am-2017-5944 [↗](#), 2017.
56. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, **Y. Ye**<sup>PD</sup>, E. Alp, S. Xu, D. Morgan, Y. Meng, and V. B. Prakapenka. Stability of ferrous-iron-rich bridgmanite under reducing mid-mantle conditions. *Proceedings of the National Academy of Sciences*, 114, 6468–6473, DOI: 10.1073/pnas.1614036114 [↗](#), 2017.  
*Press release: Advanced Photon Source Science Highlights* [↗](#)
55. **C. Nisr**<sup>PD</sup>, K. Leinenweber, V. B. Prakapenka, C. Prescher, S. Tkachev, and **S.-H. Shim**<sup>PI</sup>. Phase transition and equation of state of dense hydrous silica up to 63 GPa. *Journal of Geophysical Research - Solid Earth*, 122, 6972–6983, DOI: 10.1002/2017JB014055 [↗](#), 2017.
54. **Y. Ye**<sup>PD</sup>, V. B. Prakapenka, Y. Meng, and **S.-H. Shim**<sup>PI</sup>. Inter-comparison of the gold, platinum, and MgO pressure scales up to 140 GPa and 2,500 K. *Journal of Geophysical Research - Solid Earth*, 122, 3450–3464, DOI: 10.1002/2016JB013811 [↗](#), 2017.
53. **C. Nisr**<sup>PD</sup>, Y. Meng, A. MacDowell, J. Yan, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. Thermal expansion of SiC at high pressure–temperature and implications for thermal convection in the deep interiors of carbide exoplanets. *Journal of Geophysical Research - Planets*, 122, 124–133, DOI: 10.1002/2016JE005158 [↗](#), 2017.   
*Press release: EOS Research Spotlights* [↗](#)
52. E. J. Garnero, A. K. McNamara, and **S.-H. Shim**. Continent-sized anomalous zones with low seismic velocity at the base of Earth's mantle. *Nature Geoscience*, 9, 481–489, DOI: 10.1038/ngeo2733 [↗](#), 2016.

51. H. Piet, J. Badro, F. Nabiei, T. Dennenwaldt, **S.-H. Shim**, M. Cantoni, C. Hébert, and Philippe Gillet. Spin and valence dependence of iron partitioning in Earth's deep mantle. *Proceedings of the National Academy of Sciences*, 113, 11127–11130, DOI: 10.1073/pnas.1605290113 [↗](#), 2016.
50. K. Vilella, **S.-H. Shim**, C. G. Farnetani, and J. Badro. Spin state transition and partitioning of iron: effects on mantle dynamics. *Earth and Planetary Science Letters*, 417, 57–66, DOI: 10.1016/j.epsl.2015.02.009 [↗](#), 2015.
49. M. Pagano, A. Truitt, P. A. Young, and **S.-H. Shim**. The chemical composition of  $\tau$  Ceti and possible effects on terrestrial planets. *Astrophysical Journal*, 803, 90, DOI: 10.1088/0004-637X/803/2/90 [↗](#), 2015.
48. S. Xu, **S.-H. Shim**, and D. Morgan. Origin of  $\text{Fe}^{3+}$  in Fe-containing, Al-free mantle silicate perovskite. *Earth Planetary Science Letters*, 409, 319–328, DOI: 10.1016/j.epsl.2014.11.006 [↗](#), 2015.
47. **Y. Ye**<sup>PD</sup>, **C. Gu**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, Y. Meng, and V. B. Prakapenka. The postspinel boundary in pyrolitic compositions determined in the laser-heated diamond anvil cell. *Geophysical Research Letters*, 41, 3833–3841, DOI: 10.1002/2014GL060060 [↗](#), 2014.
46. X. Shang, **S.-H. Shim**, M. V. de Hoop, and R. D. van der Hilst. Multiple seismic reflectors in Earth's lowermost mantle. *Proceedings of the National Academy of Sciences*, 111, 2442–2446, DOI: 10.1073/pnas.1312647111 [↗](#), 2014.
45. P. A. Young, S. J. Desch, A. D. Anbar, R. Barnes, N. R. Hinkel, R. Koppurapu, N. Madhusudhan, N. Monga, M. D. Pagano, M. A. Riner, E. Scannapieco, **S.-H. Shim**, and A. Truitt. Astrobiological stoichiometry. *Astrobiology*, 14, 603–626, DOI: 10.1089/ast.2014.1143 [↗](#), 2014.
44. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, E. Cottrell, and V. B. Prakapenka. Crystal structure and compressibility of lead dioxide up to 140 GPa. *American Mineralogist*, 99, 170–177, DOI: 10.2138/am.2014.4596 [↗](#), 2014.
43. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Stability, metastability, and elastic properties of a dense silica polymorph, seifertite. *Journal of Geophysical Research - Solid Earth*, 118, B50360, DOI: 10.1002/jgrb.50360 [↗](#), 2013.
42. **C. Gu**<sup>GS</sup>, **K. Catalli**<sup>GS</sup>, **B. Grocholski**<sup>PD</sup>, L. Gao, E. Alp, P. Chow, Y. Xiao, H. Cynn, W. J. Evans, and **S.-H. Shim**<sup>PI</sup>. Electronic structure of iron in magnesium silicate glasses at high pressure. *Geophysical Research Letters*, 39, L24304, DOI: 10.1029/2012GL053950 [↗](#), 2012.
41. **B. Grocholski**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Mineralogical effects on the detectability of the post-perovskite boundary. *Proceedings of the National Academy of Sciences*, 109, 2275–2279, DOI: 10.1073/pnas.1109204109 [↗](#), 2012.
40. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, P. Dera, V. B. Prakapenka, J. Zhao, W. Sturhahn, Y. Xiao, P. Chow, H. Cynn, and W. Evans. Effects of the  $\text{Fe}^{3+}$  spin transition on the properties of aluminous perovskite – New insights for lower-mantle seismic heterogeneities. *Earth and Planetary Science Letters*, 310, 293–302, DOI: 10.1016/j.epsl.2011.08.018 [↗](#), 2011.
39. **S.-H. Shim**<sup>PI</sup>, **D. LaBounty**<sup>UG</sup>, and T. S. Duffy. Raman spectra of bixbyite,  $\text{Mn}_2\text{O}_3$ , up to 40 GPa. *Physics and Chemistry of Minerals*, 38, 685–691, DOI: 10.1007/s00269-011-0441-4 [↗](#), 2011.
38. C. Qin, R. D. van der Hilst, M. V. de Hoop, and **S.-H. Shim**. Seismic imaging of transition zone discontinuities suggests hot mantle west of Hawaii. *Science*, 332, 1068–1071, DOI: 10.1126/science.1202731 [↗](#), 2011.



37. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Stability of the MgSiO<sub>3</sub> analog NaMgF<sub>3</sub> and its implication for mantle structure in super-Earths. *Geophysical Research Letters*, 37, L14204, DOI: 10.1029/2010GL043645 ↗, 2010.
36. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, J. Zhao, W. Sturhahn, P. Chow, Y. Xiao, H. Liu, H. Cynn, and W. J. Evans. Spin state of ferric iron in MgSiO<sub>3</sub> perovskite and its effect on elastic properties. *Earth and Planetary Science Letters*, 289, 68–75, DOI: 10.1016/j.epsl.2009.10.029 ↗, 2010.
35. Q. Cao, P. Wang, R. D. van der Hilst, M. V. de Hoop, and **S.-H. Shim**. Imaging the upper mantle transition zone with a generalized Radon transform of SS precursors. *Physics of the Earth and Planetary Interiors*, 180, 80–91, DOI: 10.1016/j.pepi.2010.02.006 ↗, 2010.
34. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, J. Zhao, and W. Sturhahn. X-ray diffraction and Mössbauer spectroscopy of Fe<sup>3+</sup>-bearing Mg-silicate post-perovskite at 128–138 GPa. *American Mineralogist*, 95, 418–421, DOI: 10.2138/am.2010.3352 ↗, 2010.
33. R. F. Cooper, R. L. A. Everman, **J. Hustoft**<sup>PD</sup>, and **S.-H. Shim**. Mechanism and kinetics of reduction of a FeO–Fe<sub>2</sub>O<sub>3</sub>–CaO–MgO aluminosilicate melt in a high-CO activity environment. *American Mineralogist*, 95, 810–824, DOI: 10.2138/am.2010.3375 ↗, 2010.
32. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Thickness and Clapeyron slope of the post-perovskite boundary. *Nature*, 462, 782–785, DOI: 10.1038/nature08598 ↗, 2009.
31. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, W. Sturhahn, J. Zhao, Y. Xiao, and P. C. Chow. Spin and valence states of iron in (Mg<sub>0.8</sub>Fe<sub>0.2</sub>)SiO<sub>3</sub> perovskite. *Geophysical Research Letters*, 36, L24303, DOI: 10.1029/2009GL041262 ↗, 2009.
30. **S.-H. Shim**<sup>PI</sup> and **K. Catalli**<sup>GS</sup>. Compositional dependence of structural transition pressures in amorphous phases with mantle-related compositions. *Earth and Planetary Science Letters*, 283, 174–180, DOI: 10.1016/j.epsl.2009.04.018 ↗, 2009.
29. **S.-H. Shim**<sup>PI</sup>, A. Bengtson, D. Morgan, W. Sturhahn, **K. Catalli**<sup>GS</sup>, J. Zhao, M. Lerche, and V. B. Prakapenka. Electronic and magnetic structures of the postperovskite-type Fe<sub>2</sub>O<sub>3</sub> and implications for planetary magnetic records and deep interiors. *Proceedings of the National Academy of Sciences*, 106, 5508–5512, DOI: 10.1073/pnas.0808549106 ↗, 2009.
28. **R. Zucker**<sup>UG</sup> and **S.-H. Shim**<sup>PI</sup>. In situ Raman spectroscopy of MgSiO<sub>3</sub> enstatite up to 1550 K. *American Mineralogist*, 94, 1638–1646, DOI: 10.2138/am.2009.3210 ↗, 2009.
27. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, **J. Hustoft**<sup>PD</sup>, A. Kubo, V. B. Prakapenka, W. A. Caldwell, and M. Kunz. Crystal structure and thermoelastic properties of (Mg<sub>0.91</sub>Fe<sub>0.09</sub>)SiO<sub>3</sub> postperovskite up to 135 GPa and 2700 K. *Proceedings of the National Academy of Sciences*, 105, 7382–7386, DOI: 10.1073/pnas.0711174105 ↗, 2008.
26. **J. Hustoft**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, A. Kubo, V. B. Prakapenka, and M. Kunz. Equation of state of NaMgF<sub>3</sub> postperovskite - implications for the seismic velocity changes in the D'' region. *Geophysical Research Letters*, 35, L10309, DOI: 10.1029/2008GL034042 ↗, 2008.
25. **S. Lundin**<sup>GS</sup>, **K. Catalli**<sup>GS</sup>, **J. Santillán**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, M. Kunz, and Y. Meng. Effect of Fe on the equation of state of mantle silicate perovskite over 1 Mbar. *Physics of the Earth and Planetary Interiors*, 168, 97–102, DOI: 10.1016/j.pepi.2008.05.002 ↗, 2008.
24. **J. Hustoft**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, A. Kubo, and N. Nishiyama. Raman spectroscopy of CaIrO<sub>3</sub> postperovskite up to 30 GPa. *American Mineralogist*, 93, 1654–1658, DOI: 10.2138/am.2008.2938 ↗, 2008.

23. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. A crystalline-to-crystalline phase transition in  $\text{Ca}(\text{OH})_2$  at 8 GPa and room temperature. *Geophysical Research Letters*, 35, L05312, DOI: 10.1029/2007GL033062 [↗](#), 2008.
22. **S.-H. Shim**<sup>PI</sup>. The postperovskite transition. *Annual Reviews in Earth and Planetary Sciences*, 36, 569–599, DOI: 10.1146/annurev.earth.36.031207.124309 [↗](#), 2008.
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20. **S. P. Slotznick**<sup>UG</sup> and **S.-H. Shim**<sup>PI</sup>. In situ Raman spectroscopy measurements of  $\text{MgAl}_2\text{O}_4$  spinel up to 1400°C. *American Mineralogist*, 93, 470–476, DOI: 10.2138/am.2008.2687 [↗](#), 2008.
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18. **S.-H. Shim**<sup>PI</sup>, A. Kubo, and T. S. Duffy. Raman spectroscopy of perovskite and post-perovskite phases of  $\text{MgGeO}_3$  to 123 GPa. *Earth and Planetary Science Letters*, 260, 166–178, DOI: 10.1016/j.epsl.2007.05.027 [↗](#), 2007.
17. **J. Santillán**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, G. Shen, and V. B. Prakapenka. High-pressure phase transition in  $\text{Mn}_2\text{O}_3$  - application for the crystal structure and preferred orientation of the  $\text{CaIrO}_3$  type. *Geophysical Research Letters*, 33, L15307, DOI: 10.1029/2006GL026423 [↗](#), 2006.
16. **S.-H. Shim**<sup>PI</sup>, **S. Rekhi**<sup>PD</sup>, M. C. Martin, and R. Jeanloz. Vibrational spectroscopy and X-ray diffraction of  $\text{Cd}(\text{OH})_2$  to 23 GPa at 300 K. *Physical Review B*, 74, 024107, DOI: 10.1103/PHYSREVB.74.024107 [↗](#), 2006.
15. **S.-H. Shim**, T. S. Duffy, R. Jeanloz, and G. Shen. Stability and crystal structure of  $\text{MgSiO}_3$  perovskite to the core-mantle boundary. *Geophysical Research Letters*, 31, L10603, DOI: 10.1029/2004GL019639 [↗](#), 2004.
14. **S.-H. Shim**, T. S. Duffy, R. Jeanloz, C.-S. Yoo, and V. Iota. Raman spectroscopy and x-ray diffraction of phase transitions in  $\text{Cr}_2\text{O}_3$  to 61 GPa. *Physical Review B*, 69, 144107, DOI: 10.1103/PhysRevB.69.144107 [↗](#), 2004.
13. K. K. M. Lee, B. O'Neil, W. R. Panero, **S.-H. Shim**, L. R. Benedetti, and R. Jeanloz. Equations of state of the high-pressure phases of a natural peridotite and implications for the earth's lower mantle. *Earth and Planetary Science Letters*, 223, 381–393, DOI: 10.1016/j.epsl.2004.04.033 [↗](#), 2004.
12. C. S. Zha, W. A. Bassett, and **S.-H. Shim**. Rhenium, an in situ pressure calibrant for internally heated diamond anvil cells. *Reviews of Scientific Instruments*, 75, 2409–2418, DOI: 10.1063/1.1765752 [↗](#), 2004.
11. **S.-H. Shim**, R. Jeanloz, and T. S. Duffy. Tetragonal structure of  $\text{CaSiO}_3$  perovskite above 20 GPa. *Geophysical Research Letters*, 29, 2166, DOI: 10.1029/2002GL016148 [↗](#), 2002.
10. **S.-H. Shim**, T. S. Duffy, and K. Takemura. Equation of state of gold and its application to the phase boundaries near the 660-km depth in the mantle. *Earth and Planetary Science Letters*, 203, 729–739, DOI: 10.1016/S0012-821X(02)00917-2 [↗](#), 2002.

9. **S.-H. Shim** and T. S. Duffy. Raman spectra of  $\text{Fe}_2\text{O}_3$  to 62 GPa: Implications for thermodynamics and phase transformation. *American Mineralogist*, 87, 318–326, DOI: 10.2138/am-2002-2-314 [↗](#), 2002.
8. **S.-H. Shim**, T. S. Duffy, and G. Shen. Stability and structure of  $\text{MgSiO}_3$  perovskite to 2300-km depth conditions. *Science*, 293, 2437–2440, DOI: 10.1126/science.1061235 [↗](#), 2001.
7. **S.-H. Shim**, T. S. Duffy, and G. Shen. The post-spinel transformation in  $\text{Mg}_2\text{SiO}_4$  and its relation to the 660-km seismic discontinuity. *Nature*, 411, 571–574, DOI: 10.1038/35079053 [↗](#), 2001.
6. **S.-H. Shim**, T. S. Duffy, and G. Shen. The stability and P–V–T equation of state for  $\text{CaSiO}_3$  perovskite in the earth's lower mantle. *Journal of Geophysical Research - Solid Earth*, 105, 25955–25968, DOI: 10.1029/2000JB900183 [↗](#), 2000.
5. **S.-H. Shim**, T. S. Duffy, and G. Shen. The equation of state of  $\text{CaSiO}_3$  perovskite to 108 GPa at 300 K. *Physics of the Earth and Planetary Interiors*, 120, 327–338, DOI: 10.1016/S0031-9201(00)00154-0 [↗](#), 2000.
4. **S.-H. Shim** and T. S. Duffy. Constraints on the P–V–T equation of state of  $\text{MgSiO}_3$  perovskite. *American Mineralogist*, 85, 354–363, DOI: 10.2138/am-2000-2-314 [↗](#), 2000.
3. **S.-H. Shim**, A. Navrotsky, T. R. Gaffney, and J. E. MacDougall. Chabazite: energetics of hydration, enthalpy of formation, and effect of cations on stability. *American Mineralogist*, 84, 1870–1882, DOI: 10.2138/am-1999-11-1214 [↗](#), 1999.
2. **S.-H. Shim**, S. J. Kim, and J. H. Ahn. Quantitative analysis of alkali feldspar minerals using Rietveld refinement of X-ray diffraction data. *American Mineralogist*, 81, 1133–1140, DOI: 10.2138/am-1996-9-1011 [↗](#), 1996.
1. **S.-H. Shim**, J. H. Ahn, and S. J. Kim. Quantitative analysis of feldspar mixture samples using the Rietveld refinement method. *Journal of the Mineralogical Society of Korea*, 7, 62–79, 1994.

## Peer-Reviewed Book Chapters

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1. **S.-H. Shim**. Stability of  $\text{MgSiO}_3$  perovskite in the lower mantle. In *Earth's Deep Mantle: Structure, Composition, and Evolution*, edited by R. D. van der Hilst, J. Bass, J. Matas, and J. Trampert, volume 160 of *Geophysical Monograph Series*, 261–282. American Geophysical Union, 2005.

## Non Peer-Reviewed Articles

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2. **S.-H. Shim** and T. Lay. Deep Earth: Post-perovskite at ten. *Nature Geoscience*, 7, 621–623, 2014.
1. T. Lay, D. Heinz, M. Ishii, **S.-H. Shim**, J. Tsuchiya, T. Tsuchiya, R. Wentzcovitch, and D. Yuen. Multidisciplinary impact of the deep mantle phase transition in perovskite structure. *Eos Transactions*, 86, 1–4, 2005.

## Apps, Jupyter notebooks, and Codes

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Only the software and the codes with DOI are listed below. More software and codes can be found in Shim's GitHub repository [↗](#). All the software and codes developed by Shim are open source.

5. **S.-H. Shim**. Inverse Birch-Murnaghan equation with spline interpolation. Zenodo. DOI: 10.5281/zenodo.6349563 [↗](#), Github Repo [↗](#), 2022.

4. **S.-H. Shim.** Unit cell fitting in Jupyter. Zenodo. DOI: 10.5281/zenodo.6344949 [↗](#), Github Repo [↗](#), 2022.
3. **S.-H. Shim.** JCPDSTools - A python app for creating, converting, and revising high-pressure diffraction information file. Zenodo. DOI: 10.5281/zenodo.6349449 [↗](#), Github Repo [↗](#), 2022.
2. **S.-H. Shim.** PeakPo - A python software for X-ray diffraction analysis at high pressure and high temperature. Zenodo. DOI: 10.5281/zenodo.810199 [↗](#), Github Repo [↗](#), 2017.
1. **S.-H. Shim.** Pytheos - a python tool set for equations of state. Zenodo. DOI: 10.5281/zenodo.802392 [↗](#), Github Repo [↗](#), 2017.







# Presentations

**Tags:** Shim's recent developments are highlighted with the following symbols.

 Solar-system planets and Exoplanets     Technical developments     Educational developments

## Colloquia and Lectures

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- 2022: Advanced Photon Source High Pressure Special Interest Group Meeting, virtual 
- 2020: Seismology Seminar, Seismology Laboratory, University of California, Berkeley, CA
- 2020: School of Earth and Space Exploration, Arizona State University, Tempe, AZ 
- 2019: Department of Earth System Science, Yonsei University, Seoul, Korea 
- 2019: School of Earth and Environmental Science, Seoul National University, Seoul, Korea
- 2018: China University of Geosciences, Wuhan, China
- 2018: School of Earth and Environmental Science, Seoul National University, Seoul, Korea
- 2018: Department of Earth System Sciences, Yonsei University, Seoul, Korea
- 2018: Equation of state, Cooperative Institute for Dynamic Earth Research (CIDER)–Kavli Institute for Theoretical Physics (KITP) Program: Relating Geophysical and Geochemical Heterogeneity in the Deep Earth, Santa Barbara, CA
- 2017: Mars InSight Mission team, Jet Propulsion Laboratory, CA 
- 2017: Seismological Laboratory, California Institute of Technology, Pasadena, CA
- 2016: Public lecture on planetary interiors, KAOS foundation, Seoul, Korea 
- 2016: School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea
- 2016: Korea Basic Science Institute (KBSI), Chungju, Korea
- 2016: Lecture, Cooperative Institute for Dynamic Earth Research (CIDER), 2016 Summer Program, “Flow in the Deep Earth”, Santa Barbara, CA
- 2016: Bavarian Research Institute of Experimental Geochemistry and Geophysics (BGI) University of Bayreuth, Bayreuth, Germany
- 2016: Seismology Seminar, Seismology Laboratory, University of California, Berkeley, CA
- 2014: Department of Geology and Geophysics, University of Utah, Salt Lake City, UT
- 2014: Umbgrove Lectures, Department of Geosciences, Universiteit Utrecht, Utrecht, Nederland
- 2014: Institut de Physique du Globe de Paris (IPGP), Paris, France
- 2013: Center for the Origin, Dynamics and Evolution of Planets (CODEP), University of California, Santa Cruz, CA 
- 2012: Institut de Physique du Globe de Paris (IPGP), Paris, France
- 2011: School of Environmental Science and Engineering, Pohang University of Science and Technology, Pohang, Korea
- 2011: School of Earth and Environmental Science, Seoul National University, Seoul, Korea
- 2011: Korea Astronomy and Space Science Institute, Daejeon, Korea 
- 2011: School of Earth and Space Exploration, Arizona State University, Tempe, AZ
- 2011: Department of Geology, University of Maryland, College Park, MD

2010: Scripps Institution of Oceanography, University of California, San Diego, CA

2010: Department of Earth and Environmental Sciences, Ludwig-Maximilians University, Munich, Germany

2010: Department of Earth Sciences, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

2010: School of Earth and Environmental Science, Seoul National University, Seoul, Korea

2010: Department of Earth System Sciences, Yonsei University, Seoul, Korea

2009: Geophysics Colloquium, Princeton University, Princeton, NJ

2008: Department of Physics, University of Toronto, Toronto, Canada

2007: Department of Geological Sciences, Brown University, Providence, RI

2007: School of Earth and Environmental Science, Seoul National University, Seoul, Korea

2007: Department of Earth System Sciences, Yonsei University, Seoul, Korea

2007: Department of Earth and Environment Sciences, Chungbuk National University, Chungjoo, Korea

2006: Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, NY

2006: Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute, Troy, NY

2004: Cooperative Institute for Deep Earth Research (CIDER) Summer Workshop, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA

2004: Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA

2002: School of Earth and Environmental Science, Seoul National University, Seoul, Korea

2002: Seismological Laboratory, University of California, Berkeley, CA

2002: Seismological Laboratory, California Institute of Technology, Pasadena, CA

2001: Department of Geology and Geophysics, Yale University, New Haven, CT


2001: Department of Geology, University of Illinois, Champaign, IL


2001: Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA

## Invited Talks at Workshops

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2022: Stanford Synchrotron Radiation Lightsource (SSRL) / Linac Coherent Light Source (LCLS) Users' Meeting and Workshops, Menlo Park, CA

2021: 10th Asian Conference on High Pressure Research, Virtual 

2021: Advances in synchrotron-based research towards understanding the structure, evolution, and dynamics of Earth and planetary interiors, co-organized by Geoscience Synchrotron Users Group, GeoSoilEnviroCARS, and COMPRES, Virtual 

2019: Inelastic X-ray and Nuclear Resonant Scattering and Applications in Earth Sciences, Consortium for Materials Properties Research in Earth Sciences (COMPRES) Annual Meeting, Montana

2018: Stanford Synchrotron Radiation Lightsource (SSRL) / Linac Coherent Light Source (LCLS) Users' Meeting and Workshops, Menlo Park, CA

2018: Synchrotron Infrared Spectroscopy on Materials in Extreme, National Synchrotron Light Source (NSLS)-II and Center for Functional Nanomaterials (CFN) Users' Meeting, Brookhaven, NY

2018: Advanced Photon Source / Center for Nanoscale Materials Users Meeting, Argonne, IL

2017: 5th High power laser workshop, SLAC National Accelerator Laboratory, Menlo Park, CA

2016: Deutsches Elektronen-Synchrotron – Arizona State University workshop, Hamburg, Germany

2016: Institute for Study of the Earth's Interior (ISEI) Misasa VI Symposium, Okayama University, Japan

2015: Carbon at Extreme Conditions, Centre Européen de Calcul Atomique et Moléculaire (CECAM), CECAM-ETHZ, Lugano, Switzerland

2014: PURE-4 Meeting (IPGP-UCL), Paris, France

2014: PPv@10: A Meeting for the 10th Anniversary of the Discovery of Post-Perovskite, University of Bristol, Bristol, UK

2014: Deep Earth Processes: Windows on the Working of a Planet, London, UK

2013: Interior of the Earth, Gordon Research Conference, South Hadley, MA

2013: Stellar Stoichiometry Workshop, Tempe, AZ

2012: Structure and Dynamics of the Earth's Deep Mantle, Collège de France, Paris, France

2010: Computational Mineral Physics: Applications to Geophysics, Centre Européen de Calcul Atomique et Moléculaire (CECAM), CECAM-ETHZ, Zurich, Switzerland

2009: Interior of the Earth, Gordon Research Conference, South Hadley, MA

2009: Community Workshop, Cooperative Institute for Deep Earth Research, Marshall, CA

2008: Asian Conference in High Pressure Research, Seoul, Korea

2008: High-resolution X-ray Scattering on Earth Materials using Synchrotron Radiation, Advanced Photon Source (APS), Argonne National Laboratory, Argonne, IL

2008: High-Pressure Workshop at the Joint National Synchrotron Light Source (NSLS) and Center for Functional Nanomaterials (CFN) Users Meeting, Brookhaven National Laboratory, Upton, NY

2006: Workshop on Synergy of 21st Century High-Pressure Science and Technology Advanced Photon Source, Argonne National Laboratory, Argonne, IL



2005: Virtual Laboratory for Earth and Planetary Materials (VLab) Workshop, University of Minnesota, Minneapolis, MN





2004: Consortium for Materials Properties Research in Earth Sciences (COMPRES) Sponsored Workshop, Structure Determination by Single Crystal X-ray Diffraction at Megabar Pressures, Advanced Photon Source, Argonne National Laboratory, Argonne, IL

2004: GeoSoilEnviro Consortium for Advanced Radiation Source (GSECARS) / Consortium for Materials Properties Research in Earth Sciences (COMPRES) High-Pressure Workshop, Future Directions for the Laser-Heated Diamond Anvil Cell at the Advanced Photon Source, Argonne National Laboratory, Argonne, IL

## Invited Conference Presentations

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19. **S.-H. Shim<sup>PI</sup>**, **C. Nisr<sup>PD</sup>**, **H. Piet<sup>PD</sup>**, **H. Chen<sup>GS</sup>**, **B. Ko<sup>GS</sup>**, **T. Kim<sup>vGS</sup>**, **H. Allen-Sutter<sup>GS</sup>**, S. Charison, V. Prakapenka, M. Kunz, Z. Liu, Y. Lee, A. Chizmeshya, J. O'Rourke, B. Chen, and S. Speziale. Hydrogen in the deep mantle Abstract 10059, Goldschmidt Meeting 2022, Honolulu, HI. 
18. **S.-H. Shim<sup>PI</sup>**, **H. Piet<sup>PD</sup>**, **S. Fu<sup>PD</sup>**, **B. Ko<sup>GS</sup>**, **T. Kim<sup>vGS</sup>**, Y. Lee, V. B. Prakapenka, and S. Chariton. Impacts of hydrogen on the chemistry and structure of rocky planets' cores. Abstract DI23A-01, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA. 



17. **S.-H. Shim**<sup>PI</sup>, **H. Piet**<sup>PD</sup>, **H. Allen-Sutter**<sup>GS</sup> and **B. Kulka**<sup>GS</sup>. Hydrogen-mineral reactions at high temperatures and high pressures. Abstract MR025-07, Fall American Geophysical Union (AGU) Meeting 2020, San Francisco, CA. 
16. **S.-H. Shim**<sup>PI</sup> and **J. Dolinski**<sup>GS</sup>. Exploring Earth and planets with large databases. Abstract ED044-0002, Fall American Geophysical Union (AGU) Meeting 2020, San Francisco, CA. 
15. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, **Y. Ye**<sup>PD</sup>, E. E. Alp, Y. Meng, V. B. Prakapenka, D. Morgan, and S. Xu. Origin of the lower-mantle heterogeneities - importance of the crystal chemistry of bridgmanite. Abstract MR44A-02, Fall American Geophysical Union (AGU) Meeting 2017, New Orleans, LA.
14. **S.-H. Shim**<sup>PI</sup>, **C. Nisr**<sup>PD</sup>, M. Pagano, **H. Chen**<sup>GS</sup>, **B. Ko**<sup>GS</sup>, **S. Noble**<sup>UG</sup>, K. Leinenweber, P. Young, and S. Desch. Un-Earth-like interiors of the Earth-like planets. Abstract DI52B-01, Fall American Geophysical Union (AGU) Meeting 2015, San Francisco, CA. 
13. **S.-H. Shim**<sup>PI</sup>, **Y. Ye**<sup>PD</sup>, **B. Grocholski**<sup>PD</sup>, S. Xu, D. Morgan, J. Zhao, and E. Alp. The post-perovskite transition and mineralogical changes in the chemically heterogeneous lower mantle. Abstract MR23D-01, Fall American Geophysical Union (AGU) Meeting 2014, San Francisco, CA.
12. **S.-H. Shim**, R. D. van der Hilst, **B. Grocholski**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, Q. Cao, and X. Shang. Nature of mantle heterogeneities. Goldschmidt Conference 2011, The Geochemical Society, Prague, Czech Republic.
11. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, W. Sturhahn, and V. B. Prakapenka. Does the spin transition in mantle silicate perovskite change the seismic properties of the lower mantle? Abstract DI11B-03, Fall American Geophysical Union (AGU) Meeting 2010, San Francisco, CA.
10. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, W. Sturhahn, and V. B. Prakapenka. Iron in mantle silicate perovskite. Acta Mineralogica-Petrographica, Abstract Series, 6, 20th General Meeting of the International Mineralogical Association (IMA) 2010, Hungary, Budapest.
9. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, and **B. Grocholski**<sup>PD</sup>. Valence and spin states of iron in mantle silicate perovskite and their implications for the chemistry and mineralogy of the lower mantle. Abstract V23B-03, Eos Transactions American Geophysical Union, 91, Western Pacific Geophysics Meeting Supplement, 2010, Taipei, Taiwan.
8. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, **B. Grocholski**<sup>PD</sup>, and V. B. Prakapenka. Effect of compositional variation on the post-perovskite transition in the lowermost mantle. Japan Geoscience Union Meeting 2010, Chiba City, Japan.
7. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, and **B. Grocholski**<sup>PD</sup>. Mineralogical processes in the lower mantle and their implications for seismic heterogeneities. Abstract U23D-0066, Eos Transactions American Geophysical Union, 90, Fall Meeting Supplement, 2009, San Francisco, CA.
6. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, and **K. Catalli**<sup>GS</sup>. Size matters - lessons from the interiors of Earth and Mars. Abstract P14B-02, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA. 
5. **S.-H. Shim**<sup>PI</sup>, **J. Hustoft**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, A. Kubo, V. B. Prakapenka, and M. Kunz. Bulk sound speed and Grüneisen parameter of postperovskite and their implications for the D'' heterogeneities. The 33rd International Geology Congress 2008, Oslo, Norway.
4. **S.-H. Shim**, T. S. Duffy, R. Jeanloz, and G. Shen. Stability and crystal structure of MgSiO<sub>3</sub> perovskite in the Earth's deep mantle. Abstract U34A-01, Eos Transactions American Geophysical Union, 85, Fall Meeting Supplement, 2004, San Francisco, CA.










3. **S.-H. Shim** and R. Jeanloz. Equation of state of  $\text{MgSiO}_3$  perovskite and the chemical composition of the lower mantle. Abstract S338, Eos Transactions American Geophysical Union, 83, Spring Meeting Supplement, 2002, Washington, DC.
2. **S.-H. Shim**, T. S. Duffy, and G. Shen. The post-spinel phase boundary in  $\text{Mg}_2\text{SiO}_4$  and the 660-km seismic discontinuity. Abstract F889, Eos Transactions American Geophysical Union, 82, Fall Meeting Supplement, 2001, San Francisco, CA.
1. **S.-H. Shim**, T. S. Duffy, and G. Shen. In situ determination of phase boundary between spinel and perovskite+periclase in  $\text{Mg}_2\text{SiO}_4$  by laser heated diamond anvil cell. Abstract F1207, Eos Transactions American Geophysical Union, 81, Fall Meeting Supplement, 2000, San Francisco, CA.















## Contributed Conference Presentations





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155. **S.-H. Shim**<sup>PI</sup>, **H. Allen-Sutter**<sup>GS</sup>, S. Speziale, S. Chariton, and V. Prakapenka. Hydrogen chemistry for understanding sub-Neptunes. Abstract 404.05, Meeting of the AAS Division for Planetary Sciences 2022. 
154. **T. Kim**<sup>PD</sup>, Y. Lee, S. Chariton, V. Prakapenka, A. Pakhomova, H.-P. Liermann, Z. Liu, S. Speziale, and **S.-H. Shim**<sup>PI</sup>. Solubility of MgO in  $\text{H}_2\text{O}-\text{H}_2$  at high pressures and its implications for large water-rich planets. Abstract 107.03, Meeting of the AAS Division for Planetary Sciences 2022. 
153. **S. Fu**<sup>PD</sup>, S. Chariton, V. B. Prakapenka, A. Chizmeshya, and **S.-H. Shim**<sup>PI</sup>. Phase Relations in the Fe-Si-H Ternary up to 125 GPa and 3700 K. Abstract EGU22-3229, European Geophysical Union (EGU) Meeting 2022, Vienna, Austria and Online.
152. **S. Fu**<sup>PD</sup>, S. Chariton, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. Melting Behavior of Fe-Si-H and its Impact on Possible Stratification at the Topmost Outer Core. Goldschmidt Meeting 2022, Honolulu, HI.
151. **H. Allen-Sutter**<sup>GS</sup>, S. Chariton, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. Chemical interactions between hydrogen-rich envelopes and silicate magma oceans. Abstract MR15A-0045, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.
150. Q. Yuan, M. Li, E. Garnero, **S.-H. Shim**, and **B. Ko**<sup>GS</sup>. Investigating the dynamics of ultra-high velocity zones above Earth's core-mantle boundary. Abstract DI44B-08, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.
149. **T. Kim**<sup>vGS</sup>, S. Chariton, V. B. Prakapenka, A. Pakhomova, H.-P. Liermann, Z. Liu, S. Speziale, **S.-H. Shim**<sup>PI</sup>, and Y. Lee. Atomic-scale mixing between MgO and  $\text{H}_2\text{O}$  in the deep interiors of water-rich planets. Abstract DI32A-06, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.
148. **S. Fu**<sup>PD</sup>, S. Chariton, V. B. Prakapenka, A. Chizmeshya, and **S.-H. Shim**<sup>PI</sup>. Alloys in Fe-Si-H ternary at high pressures-temperatures and their implications for the planetary cores. Abstract DI25C-0047, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.
147. S. E. Hansen, E. Garnero, S. Rost, M. Li, and **S.-H. Shim**. Ultra-low velocity zone structure at southern latitudes based on *PcP* waveforms and historical interstation pattern referencing. Abstract DI14A-09, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.
146. **S.-H. Shim**<sup>PI</sup>, R. Alonso-Mori, A. Gleason, W. Mao, G. Morard, A. Ravasio, **B. Ko**<sup>GS</sup>, **J. Dolinski**<sup>GS</sup>, **J. Tappan**<sup>UG</sup>, D. Sokaras, B. Nagler, H. J. Lee, E. Galtier, R. Bolis, J.-A. Hernandez, M. Guarguaglini, A. Benuzzi-Mounaix, T. Vinci, G. Fiquet, and M. Baron. Spin state of iron in dynamically compressed

olivine melt. Abstract MR12A-08, Fall American Geophysical Union (AGU) Meeting 2021, New Orleans, LA.

145. **T. Kim**<sup>VGs</sup>, J. Lee, S. Chariton, V. B. Prakapenka, R. Husband, N. Giordano, H.-P. Liermann, and **S.-H. Shim**<sup>PI</sup>. Water may limit silicon amount in the Earth's core. Abstract 07-0934, 10th Asian Conference on High Pressure Research 2021.
144. **S.-H. Shim**<sup>PI</sup>. Solubility of magnesium in water at high pressures and its implications for Uranus. Abstract 314.03, Meeting of the AAS Division for Planetary Sciences 2021. 
143. **T. Kim**<sup>VGs</sup>, S. Chariton, V. Prakapenka, A. Pakhomova, H.-P. Liermann, Z. Liu, S. Speziale, **S.-H. Shim**<sup>PI</sup>, and Y. J. Lee Atomic-scale mixing between MgO and H<sub>2</sub>O in the deep interiors of water-rich planets. Abstract 495, Europlanet Science Congress 2021, Virtual. 
142. **S.-H. Shim**, **C. Nisr**<sup>PD</sup>, **T. Kim**<sup>VGs</sup>, Y. J. Lee, A. Chizmeshya, K. Leinenweber, S. Chariton, V. Prakapenka, S. Speziale, Z. Liu, and H.-P. Liermann. Mineral-Water Reaction at High Pressures - Implications for Uranus and Neptune. Abstract 1208, Lunar and Planetary Science Conference 2021, Houston, TX. 
141. **S. Fu**<sup>PD</sup> and **S.-H. Shim**<sup>PI</sup>. Hydrogen Storage in FeSi Alloy at High Pressure: Implications for the Composition and Structure of Rocky Planets' Cores. Abstract 1735, Lunar and Planetary Science Conference 2021, Houston, TX.
140. **S. Fu**<sup>PD</sup>, K. Leinenweber, **S.-H. Shim**. Potential storage of molecular hydrogen in CaTiO<sub>3</sub> perovskite in the deep interiors of rocky planets. AASTCS 8: Habitable Worlds, 2021, Virtual.
139. **S.-H. Shim**, **C. Nisr**<sup>PD</sup>, **T. Kim**<sup>VGs</sup>, Y. Lee, K. Leinenweber, A. Chizmeshya, S. Speziale, V. Prakapenka, C. Prescher, S. Chariton, T. Sergey, Y. Meng, Z. Liu. H<sub>2</sub>O-rock reactions at the deep interiors of water-rich planets. AASTCS 8: Habitable Worlds, 2021, Virtual. 
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137. **H. Allen-Sutter**<sup>GS</sup>, V. B. Prakapenka, S. Chariton, S. Speziale, and **S.-H. Shim**<sup>PI</sup>. Reduction of iron by hydrogen in early planetary mantles. Abstract DI005-0007, Fall American Geophysical Union (AGU) Meeting 2020, San Francisco, CA. 
136. **B. Ko**<sup>GS</sup>, S. Chariton, V. B. Prakapenka, B. Chen, S. Yu, E. Garnero, M. Li, and **S.-H. Shim**<sup>PI</sup>. Water-induced diamond formation at the Earth's core-mantle boundary. Abstract DI005-0023, Fall American Geophysical Union (AGU) Meeting 2020, San Francisco, CA. 
135. E. Garnero, S. Yu, **S.-H. Shim**, M. Li, **B. Ko**<sup>GS</sup>, M. S. Thorne, and C. Zhao. Ultra high velocity zones at the core-mantle boundary. Abstract DI008-05, Fall American Geophysical Union (AGU) Meeting 2020, San Francisco, CA.
134. **H. Allen-Sutter**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Effects of water on the mineralogy of carbon-rich exoplanets. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2020. 
133. **B. Kulka**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Toward oxygen fugacity control in laser-heated diamond-anvil cell. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2020.
132. **B. Ko**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Temperature-dependent solubility of uranium in silicate perovskites in the Earth's lower mantle. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2020.

131. **S.-H. Shim**<sup>PI</sup>. Superstoichiometric alloying of FeNi with H and hydrogen storage in the interiors of giant planets. Abstract 216.01, Meeting of the AAS Division for Planetary Sciences 2020. 
130. **J. G. O'Rourke**<sup>PD</sup> and **S.-H. Shim**<sup>PI</sup>. Hydrogenation of the Martian core by hydrated mantle minerals with implications for the early dynamo. Abstract 2475, Lunar and Planetary Science Conference 2020, Houston, TX. 
129. **H. Piet**<sup>PD</sup>, K. Leinenweber, E. Greenberg, S. Chariton, V. B. Prakapenka, P. R. Buseck, and **S.-H. Shim**<sup>PI</sup>. A potential stratification of the core of Mars caused by hydrogen. Abstract 3025, Exoplanets in our Backyard Meeting 2020, Houston, TX. 
128. **S.-H. Shim**<sup>PI</sup>, **C. Nisr**<sup>PD</sup>, **T. Kim**<sup>VG</sup>, Y. Lee, **H. Chen**<sup>GS</sup>, K. Leinenweber, A. V. G. Chizmeshya, S. Speziale, V. B. Prakapenka, C. Prescher, S. Tkachev, Y. Meng, and Z. Liu. Experimental Observations on water-rock interaction at high pressures and their implications for the interiors of Uranus and Neptune. Abstract 3027, Exoplanets in our Backyard Meeting 2020, Houston, TX. 
127. **T. Kim**<sup>VG</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, H.-P. Liermann, S. Speziale, Y. Lee. High solubility of Mg in H<sub>2</sub>O at high pressures and its implications for the interiors of water-rich planets. Abstract 3031, Exoplanets in our Backyard Meeting 2020, Houston, TX. 
126. **H. Allen-Sutter**<sup>GS</sup>, S. Speziale, V. B. Prakapenka, and **S.-H. Shim**<sup>PI</sup>. Interaction between iron/magnesium oxides and hydrogen. Abstract 3036, Exoplanets in our Backyard Meeting 2020, Houston, TX. 
125. C. M. Lisse, S. J. Desch, C. T. Unterborn, S. R. Kane, P. R. Young, H. E. Hartnett, N. R. Hinkel, **S.-H. Shim**, and E. E. Mamajek. Procedure for observing rocky exoplanets to maximize the likelihood of atmospheric oxygen biosignatures. Abstract 3064, Exoplanets in our Backyard Meeting 2020, Houston, TX. 
124. **S.-H. Shim**<sup>PI</sup>, **H. Piet**<sup>PD</sup>, **J. O'Rourke**<sup>PD</sup>, K. Leinenweber, V. B. Prakapenka, E. Greenberg, and P. Buseck. Possible immiscibility of iron hydride and iron sulfide in the Martian core. Abstract EPSC-DPS2019-188, European Planetary Science Congress - Division for Planetary Science Joint Meeting 2019, Geneva, Switzerland. 
123. **S.-H. Shim**<sup>PI</sup>, **C. Nisr**<sup>PD</sup>, **H. Chen**<sup>GS</sup>, K. Leinenweber, A. V. G. Chizmeshya, V. B. Prakapenka, C. Prescher, S. Tkachev, Y. Meng, and Z. Liu. Breaking the barrier between silica and water in the deep interiors of water-world exoplanets. Abstract EPSC-DPS2019-189, European Planetary Science Congress - Division for Planetary Science Joint Meeting 2019, Geneva, Switzerland. 
122. **H. Piet**<sup>PD</sup>, K. Leinenweber, E. Greenberg, V. B. Prakapenka, P. R. Buseck, and **S.-H. Shim**<sup>PI</sup>. Hydrogen and sulfur in metallic iron in the core of Mars. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2019, Big Sky, MT. 
121. **H. Chen**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Mineralogy of the hydrous lower mantle. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2019, Big Sky, MT. 
120. **H. Allen-Sutter**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Oxidation of the interiors of carbide exo-planets. Abstract 341-354, Astrobiology Science Conference (AbSciCon) 2019, Seattle, WA. 
119. **J. Dolinski**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Teaching resource in Jupyter notebooks for accessing and analyzing large research databases in Earth and planetary science. Abstract ED53F-0904, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA. 
118. **J. Dolinski**<sup>GS</sup>, K. Leinenweber, V. B. Prakapenka, E. Greenberg, D. Zhang, A. Wittmann, W. Bi, E. Alp, and **S.-H. Shim**<sup>PI</sup>. Effects of Mg/Si ratio on the mineralogy of the Martian mantle constrained by 

- high-pressure experiments. Abstract DI42A-07, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA.
117. **H. Allen-Sutter**<sup>GS</sup>, K. Leinenweber, V. B. Prakapenka, E. Greenberg, and **S.-H. Shim**<sup>PI</sup>. Chemical reaction between silicon carbide and water and its implication for the stability of carbide exo-planets. Abstract DI41C-0017, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA.
  116. **B. Ko**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, E. Greenberg, and V. B. Prakapenka. The solubility of uranium in bridgmanite in the Earth's lower mantle. Abstract DI41C-0017, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA.
  115. **T. Kim**<sup>VG</sup>, **S.-H. Shim**, B. Ko, E. Greenberg, V. B. Prakapenka, and Y. Lee. Low melting temperatures of anhydrous and hydrous mantle materials at the core-mantle boundary. Abstract DI41C-0017, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA.
  114. C. Millsaps, M. Li, C. Unterborn, and **S.-H. Shim**. A platform to estimate physical properties and thermal evolution pathways of exoplanet interiors. Abstract P51G-3440, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA. 
  113. **H. Piet**<sup>PD</sup>, **H. Allen-Sutter**<sup>GS</sup>, E. Greenberg, V. B. Prakapenka, P. R. Buseck, and **S.-H. Shim**<sup>PI</sup>. Challenges in high-pressure experiments on hydrogen in iron alloys-discrepancies among hydrogen sources. Abstract MR21A-07, Fall American Geophysical Union (AGU) Meeting 2019, San Francisco, CA.
  112. **J. Dolinski**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, and V. B. Prakapenka. Mineralogy of the silicon-rich mantle: implications for Mars and exoplanets. Abstract 3055, Lunar and Planetary Science Conference (LPSC) 2019, Houston TX.
  111. **H. Piet**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, E. Greenberg, and V. B. Prakapenka. Hydrogen and sulfur in metallic iron at high pressure and high temperature and implications for the cores of Earth and Mars. Abstract DI43C-0031, Fall American Geophysical Union (AGU) Meeting 2018, Washington, DC. 
  110. **J. O'Rourke**<sup>PD</sup>, C. Gillmann, P. J. Tackley, and **S.-H. Shim**. Chemistry Controls Dynamos in Metallic Cores: New Perspectives from Venus and Mars. Abstract GP12A-01, Fall American Geophysical Union (AGU) Meeting 2018, Washington, DC. 
  109. S. Yu, E. Garnero, M. Li, and **S.-H. Shim**. Ultra-High Velocity Zones (UHVZs) at Earth's core mantle boundary. Abstract DI53A-0042, Fall American Geophysical Union (AGU) Meeting 2018, Washington, DC.
  108. **S.-H. Shim**<sup>PI</sup>. Hydrogen in the deep interiors of Earth and exoplanets. Stanford Synchrotron Radiation Lightsource (SSRL) / Linac Coherent Light Source (LCLS) Users' Meeting and Workshops 2018, Menlo Park, CA. 
  107. **S.-H. Shim**<sup>PI</sup>. New dense hydrous silica phases stable in the Earth's deep mantle. Synchrotron Infrared Spectroscopy on Materials in Extreme, National Synchrotron Light Source II (NSLS-II) and Center for Functional Nanomaterials (CFN) Users' Meeting 2018, Brookhaven, NY.
  106. **S.-H. Shim**<sup>PI</sup>. Probing the valence state of Fe in mantle Mg-silicate perovskite with synchrotron X-ray. Advanced Photon Source (APS) / Center for Nanoscale Materials (CNM) Users Meeting 2018, Argonne, IL.
  105. **B. Ko**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, M. Kunz, and E. E. Alp. Incorporation of calcium into bridgmanite in Earth's lower mantle. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2018, Santa Ana Pueblo, NM.

104. **J. Dolinski**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup> and K. Leinenweber. Mineralogy of Martian interior with isotopic chemical model. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2018, Santa Ana Pueblo, NM. 
103. **B. Kulka**<sup>UG</sup>, **J. Dolinski**<sup>GS</sup>, **J. Tappan**<sup>UG</sup>, **S.-H. Shim**<sup>PI</sup>, and K. Leinenweber. The bridgmanite–majorite–akimotoite triple point measured in multi-anvil press and laser-heated diamond anvil cell. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2018, Santa Ana Pueblo, NM. 
102. **J. G. O'Rourke**<sup>PD</sup> and **S.-H. Shim**. Suppressing the Martian dynamo with hydrogenation of the core by hydrated mantle minerals. Differentiation: Building the Internal Architecture of Planets 2018, Pasadena, CA. 
101. **J. G. O'Rourke**<sup>PD</sup> and **S.-H. Shim**. Suppressing the Martian dynamo with ongoing hydrogenation of the core by hydrated mantle minerals. Abstract 2390, 49th Lunar and Planetary Science Conference 2018, Houston, TX. 
100. **B. Ko**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, M. Kunz, and E. E. Alp. Incorporation of calcium in bridgmanite in the deep mantle. Abstract MR43A-0479, Fall American Geophysical Union (AGU) Meeting 2017, New Orleans, LA.
99. **H. Piet**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, **J. Tappan**<sup>UG</sup>, K. Leinenweber, E. Greenberg, and V. B. Prakapenka. Dehydration of  $\delta$ -AlOOH in the lower mantle. Abstract MR43A-0462, Fall American Geophysical Union (AGU) Meeting 2017, New Orleans, LA.
98. **H. Chen**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, M. Kunz, V. B. Prakapenka, H. Bechtel, and Z. Liu. Mineralogy of the hydrous lower mantle. Abstract MR43A-0461, Fall American Geophysical Union (AGU) Meeting 2017, New Orleans, LA.
97. **C. Nisr**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, and A. V. G. Chizmeshya. Raman spectroscopy of water-rich stishovite and dense high-pressure silica up to 55 GPa. Abstract MR43A-0457, Fall American Geophysical Union (AGU) Meeting 2017, New Orleans, LA.
96. **S. Noble**<sup>UG</sup>, **S.-H. Shim**<sup>PI</sup>, R. L. Hervig, and V. B. Prakapenka. Solubility of nitrogen in stishovite: a possible storage mechanism for nitrogen in Earth's deep mantle. Abstract MR31A-2663, Fall American Geophysical Union (AGU) Meeting 2016, San Francisco, CA. 
95. P. Piet, J. Badro, F. Nabiei, T. Dennenwaldt, **S.-H. Shim**, M. Cantoni, C. Hebert, and P. Gillet. Spin and valence dependence of iron partitioning in Earth's deep mantle. Abstract DI41C-2640, Fall American Geophysical Union (AGU) Meeting 2016, San Francisco, CA.
94. **S.-H. Shim**<sup>PI</sup>, **Y. Ye**<sup>PD</sup>, and V. B. Prakapenka. Inter-comparison of the gold, platinum, and MgO pressure scales up to 145 GPa and 2,500 K. Abstract MR12A-05, Fall American Geophysical Union (AGU) Meeting 2016, San Francisco, CA.
93. **S.-H. Shim**<sup>PI</sup>. Un-Earth-like interiors of Earth-like exoplanets. International Union of Crystallography (IUCr) High-Pressure Workshop, September 20–24, 2016, Pohang, Korea. 
92. **C. Nisr**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, R. Hervig, V. B. Prakapenka, Y. Meng, and X. Liu. Stability of pure hydrous silica at geotherm temperatures up to 70 GPa. Abstract MR23B-2660, Fall American Geophysical Union (AGU) Meeting 2015, San Francisco, CA.

91. **H. Chen**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, Y. Meng, and V. B. Prakapenka. Crystal structure of pure and aluminous calcium silicate perovskites at mantle related pressure and temperature. Abstract MR23B-2659, Fall American Geophysical Union (AGU) Meeting 2015, San Francisco, CA.
90. **B. Ko**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. Effects of compositional variation of basalt on subducting slabs over time. Abstract MR13C-2711, Fall American Geophysical Union (AGU) Meeting 2015, San Francisco, CA.
89. **S.-H. Shim**<sup>PI</sup>, **B. Grocholski**<sup>PD</sup>, **Y. Ye**<sup>PD</sup>, E. Alp, S. Xu, D. Morgan, Y. Meng, and V. B. Prakapenka. Low Fe<sup>3+</sup> in bridgmanite and possible existence of an oxidizing layer in the mid mantle. Abstract DI14A-04, Fall American Geophysical Union (AGU) Meeting 2015, San Francisco, CA.
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87. **S.-H. Shim**<sup>PI</sup>. Low Fe<sup>3+</sup> in bridgmanite in the mid mantle. Carbon at Extreme Conditions, Centre Européen de Calcul Atomique et Moléculaire (CECAM), 2015, Lugano, Switzerland.
86. **S.-H. Shim**<sup>PI</sup>, **C. Nisr**<sup>PD</sup>, **H. Chen**<sup>GS</sup>, **B. Ko**<sup>GS</sup>, M. D. Pagano, S. Desch, and P. A. Young. Un-Earth-like interiors of Earth-like exoplanets. Abstract #5020, Comparative Tectonics and Geodynamics of Venus, Earth, and Rocky Exoplanets, 2015, Pasadena, CA. ☹
85. A. Lorenzo, S. J. Desch, **S.-H. Shim**, and D. Nys. Effect of Fe redox state and Mg/Si ratio on exoplanet mass-radius relations. Abstract #2908, 46th Lunar and Planetary Science Conference 2015, Houston, TX. ☹
84. **C. Nisr**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, R. L. Hervig, V. B. Prakapenka, and Y. Meng. Water in Al-free stishovite up to 65 GPa and 2000 K. Abstract MR21A-4302, Fall American Geophysical Union (AGU) Meeting 2014, San Francisco, CA.
83. **Y. Ye**<sup>PD</sup>, **C. Gu**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, and Y. Meng. In situ measurements of the post-spinel and post-garnet phase boundaries in pyrolite at 17–32 GPa and 1500–2400 K. Abstract DI41B-4331, Fall American Geophysical Union (AGU) Meeting 2014, San Francisco, CA.
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81. **S.-H. Shim**<sup>PI</sup>. Un-Earth-like interiors of Earth-like exoplanets. Search for Life Beyond the Solar System. March 16–21, 2014, Tucson, AZ. ☹
80. **C. Nisr**<sup>PD</sup> and **S.-H. Shim**<sup>PI</sup>. Thermal expansion of SiC in the deep interiors of carbide exoplanets. Search for Life Beyond the Solar System. March 16–21, 2014, Tucson, AZ. ☹
79. **S.-H. Shim**<sup>PI</sup>, **Y. Ye**<sup>PD</sup>, V. B. Prakapenka, and Y. Meng. Effects of iron and aluminum on phase boundaries at 600–800 km depths. Abstract EGU2014-8674, European Geophysical Union Meeting 2014, Vienna, Austria.
78. **C. Nisr**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, K. Leinenweber, and V. B. Prakapenka. Effect of water on the compressional behaviors of SiO<sub>2</sub> stishovite up to 30 GPa. Abstract MR21A–2328, Fall American Geophysical Union (AGU) Meeting 2013, San Francisco, CA.

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72. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka. Stability and compressibility of seifertite from 1 bar to 140 GPa. Abstract MR54A–08, Fall American Geophysical Union (AGU) Meeting 2012, San Francisco, CA.
71. **S.-H. Shim**, Q. Cao, R. D. van der Hilst, and M. V. De Hoop. Structure and petrology of the mantle beneath Hawaii constrained by seismic discontinuity imaging and mineral phase relations. Goldschmidt Conference 2011, The Geochemical Society, Prague, Czech Republic.
70. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Depth and thickness of the post-perovskite boundary in pyrolitic and San Carlos olivine compositions. Abstract MR32A–08, Fall American Geophysical Union (AGU) Meeting 2010, San Francisco, CA.
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65. **B. Grocholski**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, and V. B. Prakapenka. Stability of mantle silicate in Super-earths: insights from a high-pressure study of neighborite. Acta Mineralogica-Petrographica, Abstract Series, 6, 20th General Meeting of the International Mineralogical Association (IMA) 2010, Hungary, Budapest.

64. **B. Grocholski<sup>PD</sup>**, **S.-H. Shim<sup>PI</sup>**, and V. B. Prakapenka. Detectability of the post-perovskite transition in mantle-related multi-phase systems. *Acta Mineralogica-Petrographica, Abstract Series*, 6, 20th General Meeting of the International Mineralogical Association (IMA) 2010, Hungary, Budapest.
63. **K. Catalli<sup>GS</sup>**, **S.-H. Shim<sup>PI</sup>**, and W. Sturhahn. Synchrotron spectroscopy of Fe-bearing MgSiO<sub>3</sub> perovskite and post-perovskite to over 1 Mbar. *Acta Mineralogica-Petrographica, Abstract Series*, 6, 20th General Meeting of the International Mineralogical Association (IMA) 2010, Hungary, Budapest.
62. **B. Grocholski<sup>PD</sup>**, **S.-H. Shim<sup>PI</sup>**, and V. B. Prakapenka. Post-perovskite phase transition in compositions related to mantle rocks. *Goldschmidt Conference 2010*, The Geochemical Society, Knoxville, TN.
61. **B. Grocholski<sup>PD</sup>**, **S.-H. Shim<sup>PI</sup>**, and V. B. Prakapenka. The mantle convection in the super-earths; implications from high-pressure experiments on silicate analogs. Abstract 1515, *Proceedings of the Lunar and Planetary Science Conference 2010*, Houston, TX.
60. **S.-H. Shim<sup>PI</sup>**, **K. Catalli<sup>GS</sup>**, and V. B. Prakapenka. Seismic detectability of the postperovskite boundary. Abstract DI21B-01, *Eos Transactions American Geophysical Union*, 90, Fall Meeting Supplement, 2009, San Francisco, CA.
59. **K. Catalli<sup>GS</sup>**, **S.-H. Shim<sup>PI</sup>**, P. Dera, V. B. Prakapenka, J. Zhao, W. Sturhahn, P. Chow, Y. Xiao, H. Cynn, and W. J. Evans. Volume collapse of iron,aluminum-bearing perovskite at mid-lower mantle. Abstract DI12A-04, *Eos Transactions American Geophysical Union*, 90, Fall Meeting Supplement, 2009, San Francisco, CA.
58. **B. Grocholski<sup>PD</sup>**, **S.-H. Shim<sup>PI</sup>**, J. Zhao, W. Sturhahn, Y. Xiao, and P. Chow. Spin and valence states of iron in (Mg<sub>0.8</sub>Fe<sub>0.2</sub>)SiO<sub>3</sub> perovskite. Abstract DI23A-1671, *Eos Transactions American Geophysical Union*, 90, Fall Meeting Supplement, 2009, San Francisco, CA.
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54. **B. Grocholski<sup>PD</sup>**, **S.-H. Shim<sup>PI</sup>**, J. Zhao, W. Sturhahn, P. Chow, and Y. Xiao. Synchrotron Mössbauer spectroscopy of (Mg<sub>0.8</sub>Fe<sub>0.2</sub>)SiO<sub>3</sub> perovskite to 70 GPa. *Gordon Research Conferences Earth Interior 2009*, South Hadley, MA.
53. **K. Catalli<sup>GS</sup>**, **S.-H. Shim<sup>PI</sup>**, P. Dera, V. B. Prakapenka, J. Zhao, W. Sturhahn, P. Chow, Y. Xiao, H. Cynn, and W. J. Evans. Volume collapse of Fe<sup>3+</sup>-Al perovskite at mid-lower mantle pressures. *Gordon Research Conferences Earth Interior 2009*, South Hadley, MA.
52. **S.-H. Shim<sup>PI</sup>**, and **K. Catalli<sup>GS</sup>**. Does volume change drive the charge disproportionation of iron in the lower mantle? *Gordon Research Conferences Earth Interior 2009*, South Hadley, MA.



51. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, and V. B. Prakapenka. Thickness of the post-perovskite boundary in Fe<sup>2+</sup> and Fe<sup>3+</sup> bearing systems. Abstract DI31C–1804, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
50. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, J. Zhao, W. Sturhahn, and H. Liu. Spin transition in Fe<sup>3+</sup> in Mg-silicate perovskite. Abstract MR31A–1822, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
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47. Q. Cao, P. Wang, R. D. van der Hilst, M. de Hoop, and **S.-H. Shim**. High resolution seismic imaging of transition zone beneath the Hawaii volcano chain: Evidence for deep-rooted mantle plume. Abstract S21A–1806, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
46. S. Speziale, **S.-H. Shim**, and H.-J. Reichmann. Sound velocity of MgSiO<sub>3</sub> glass to 24 GPa. Abstract MR32B–02, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
45. A. Bengtson, D. Morgan, and **S.-H. Shim**. Stable spin and magnetic arrangements in Fe<sub>2</sub>O<sub>3</sub> post-perovskite. Abstract MR31A–1820, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
44. **R. Zucker**<sup>UG</sup> and **S.-H. Shim**<sup>PI</sup>. In situ Raman study on the phase transition at 1500 K in MgSiO<sub>3</sub> enstatite. Abstract MR53A–1709, Eos Transactions American Geophysical Union, 89, Fall Meeting Supplement, 2008, San Francisco, CA.
43. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, **J. Hustoft**<sup>PD</sup>, A. Kubo, and V. B. Prakapenka. Rietveld refinements of (Mg<sub>0.91</sub>Fe<sub>0.09</sub>)SiO<sub>3</sub> postperovskite up to 135 GPa and 2700 K. Abstract U51A–04, Eos Transactions American Geophysical Union, 89, Spring Meeting Supplement, 2008.
42. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, A. Kubo, and V. B. Prakapenka. The effect of Fe<sup>3+</sup> on the equations of state of Mg-silicate perovskite and post-perovskite. The 33rd International Geology Congress, 2008, Oslo, Norway.
41. **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, **J. Hustoft**<sup>PD</sup>, A. Kubo, V. B. Prakapenka, W. Caldwell, and M. Kunz. Changes in crystal structure and thermo-elastic properties of (Mg,Fe)SiO<sub>3</sub> across the post-perovskite transition. Abstract U12A–07, Eos Transactions American Geophysical Union, 88, Fall Meeting Supplement, 2007, San Francisco, CA.
40. **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, V. B. Prakapenka, A. Kubo, W. Sturhahn, J. Zhao, M. Kunz, and W. Caldwell. Synthesis and crystal structure of ferric-rich MgSiO<sub>3</sub>-perovskite. Abstract MR31B–0362, Eos Transactions American Geophysical Union, 88, Fall Meeting Supplement, 2007, San Francisco, CA.
39. **J. Hustoft**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, A. Kubo, V. B. Prakapenka, W. A. Caldwell, and M. Kunz. The post-perovskite transition in NaMgF<sub>3</sub> measured under an Ar medium. Abstract DI53A–1101, Eos Transactions American Geophysical Union, 88, Fall Meeting Supplement, 2007, San Francisco, CA.




38. P. Wang, R. D. van der Hilst, M. V. de Hoop, and **S.-H. Shim**. Inverse scattering of ScS and SKKS waves: high resolution, large scale imaging of Earth's core-mantle boundary region. Abstract U44A-04, Eos Transactions American Geophysical Union, 88, Fall Meeting Supplement, 2007, San Francisco, CA.
37. Q. Cao, R. D. van der Hilst, M. V. de Hoop, and **S.-H. Shim**. Fine scale imaging of structure at and near the mantle transition zone using a generalized Radon transform. Eos Transactions American Geophysical Union, 88, Fall Meeting Supplement, 2007, San Francisco, CA.
36. **J. Hustoft**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, A. Kubo, V. B. Prakapenka, W. A. Caldwell, and M. Kunz. The equation of state and phase boundary of post-perovskite in (Mg,Fe)SiO<sub>3</sub> and NaMgF<sub>3</sub>. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2007, Lake Morey, VT.
35. **S.-H. Shim**<sup>PI</sup>. Development of an X-ray diffraction analysis program suite for large data sets. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2007, Lake Morey, VT.
34. **S. Lundin**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, **K. Catalli**<sup>GS</sup>, **J. Santillán**<sup>PD</sup>, V. B. Prakapenka, M. Kunz, and W. Caldwell. Effect of pressure scale inconsistency on the determination of the equation of state of (Mg,Fe)SiO<sub>3</sub> perovskite. Abstract MR52A-01, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
33. **S. P. Slotznick**<sup>UG</sup> and **S.-H. Shim**<sup>PI</sup>. In situ Raman spectroscopy measurements of spinel up to 1400 °C. Abstract MR43B-1084, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
32. **K. Catalli**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. The effect of deviatoric stress on the high-pressure phase stability of Ca(OH)<sub>2</sub>. Abstract MR11B-0137, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
31. **S.-H. Shim**<sup>PI</sup>, A. Kubo, T. S. Duffy, and R. J. Cava. Raman spectroscopy of perovskite, post-perovskite, and glass in MgGeO<sub>3</sub> to 1.2 Mbar. Abstract U33B-04, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
30. A. Kubo, T. S. Duffy, B. Kiefer, **S.-H. Shim**, G. Shen, V. B. Prakapenka, and R. J. Cava. Structure refinement of MgGeO<sub>3</sub> post-perovskite phase to 1 Mbar. Abstract MR21B-0025, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
29. P. Wang, R. B. van der Hilst, M. V. de Hoop, P. Ma, L. Tenorio, and **S.-H. Shim**. 3-D seismic exploration of Earth's deep interior reveals intermittent D'' stratification. Abstract U33B-06, Eos Transactions American Geophysical Union, 87, Fall Meeting Supplement, 2006, San Francisco, CA.
28. **K. Catalli**<sup>GS</sup> and **S.-H. Shim**<sup>PI</sup>. X-ray diffraction and Raman spectroscopy study of Ca(OH)<sub>2</sub>-portlandite to 26 GPa at 300 K under quasi-hydrostatic conditions. Annual Meeting of Consortium for Materials Properties Research in Earth Sciences (COMPRES) 2006, Snowbird, UT.
27. **S.-H. Shim**<sup>PI</sup>, R. Lamm, **S. Rekh**<sup>PD</sup>, **K. Catalli**<sup>GS</sup>, **J. Santillán**<sup>PD</sup>, and **S. Lundin**<sup>GS</sup>. New micro-Raman spectroscopy systems for high-temperature studies in the diamond anvil cell. Abstract MR13B-02, Eos Transactions American Geophysical Union, 86, Fall Meeting Supplement, 2005, San Francisco, CA.
26. **J. Santillán**<sup>PD</sup> and **S.-H. Shim**<sup>PI</sup>. High pressure phase transition in Mn<sub>2</sub>O<sub>3</sub> to the CaIrO<sub>3</sub>-type phase. Abstract MR23B-0050, Eos Transactions American Geophysical Union, 86, Fall Meeting Supplement, 2005, San Francisco, CA.










25. **S. Lundin**<sup>GS</sup>, **S.-H. Shim**<sup>PI</sup>, G. Shen, V. B. Prakapenka, H. Liu, and Y. Meng. X-ray diffraction study of ferric calcium silicate perovskite to 62 GPa. Abstract MR23A-0049, Eos Transactions American Geophysical Union, 86, Fall Meeting Supplement, 2005, San Francisco, CA.
24. R. A. Lamm, P. Wang, M. D. Hoop, R. D. van der Hilst, and **S.-H. Shim**. Imaging structure at and near upper mantle discontinuities using a generalized Radon transform. Abstract DI41A-1249, Eos Transactions American Geophysical Union, 86, Fall Meeting Supplement, 2005, San Francisco, CA.
23. T. S. Duffy, A. Kubo, S. R. Shieh, G. Shen, V. B. Prakapenka, B. Kiefer, and **S.-H. Shim**. Compressibility and structural evolution of germanate and silicate post-perovskite phases. Abstract MR22A-07, Eos Transactions American Geophysical Union, 86, Fall Meeting Supplement, 2005, San Francisco, CA.
22. **S. Rekhi**<sup>PD</sup>, **S.-H. Shim**<sup>PI</sup>, M. Martin, and R. Jeanloz. X-ray diffraction and vibrational spectroscopy studies on brucite-type  $\beta$ -cadmium hydroxide to 36 GPa. Abstract T41B-1180, Eos Transactions American Geophysical Union, 85, Fall Meeting Supplement, 2004, San Francisco, CA.
21. **S.-H. Shim**, T. S. Duffy, R. Jeanloz, and G. Shen. In situ x-ray diffraction study of MgSiO<sub>3</sub> perovskite to the core-mantle boundary conditions. Abstract MR21A-02, Eos Transactions American Geophysical Union, 85, Fall Meeting Supplement, 2004, San Francisco, CA.
20. **S.-H. Shim**, K. K. Lee, and R. Jeanloz. Chemical composition of the lower mantle. Study of Matter at Extreme Conditions Conference, 2003, Miami Beach, FL.
19. **S.-H. Shim**, M. R. Frank, Y. Fei, and R. Jeanloz. Comparison of gold and MgO pressure scales at 22–56 GPa and 300–1150 K and its implications for mantle models. Abstract S21E-0364, Eos Transactions American Geophysical Union, 84, Spring Meeting Supplement, 2003.
18. T. S. Duffy and **S.-H. Shim**. Mantle mineralogy and mineral physics: Paradigms and paradoxes. Abstract S12D-02, Eos Transactions American Geophysical Union, 84, Spring Meeting Supplement, 2003.
17. **S.-H. Shim**, R. Jeanloz, and T. S. Duffy. Tetragonal structure of CaSiO<sub>3</sub> perovskite at 20–46 GPa. Abstract F616, Eos Transactions American Geophysical Union, 83, Fall Meeting Supplement, 2002.
16. R. Jeanloz, K. K. Lee, and **S.-H. Shim**. Challenging the standard model - equation of state of natural peridotite at lower-mantle conditions. Abstract F626, Eos Transactions American Geophysical Union, 83, Fall Meeting Supplement, 2002.
15. **S.-H. Shim**, T. Kenichi, and T. S. Duffy. New P–V–T equation of state of gold: Application to the post-spinel phase transition and the 660-km seismic discontinuity. Abstract F899, Eos Transactions American Geophysical Union, 82, Spring Meeting Supplement, 2001.
14. T. S. Duffy, **S.-H. Shim**, S. Shieh, and S. Speziale. Experimental studies of crystal structures and elasticity in the deep mantle. Abstract F1108, Eos Transactions American Geophysical Union, 82, Fall Meeting Supplement, 2001.
13. **S.-H. Shim**, T. S. Duffy, and G. Shen. Stability and structure of magnesium silicate perovskite to 2300-km depth in the mantle. The 11th Annual Goldschmidt Conference 2001, The Geochemical Society, Hot Springs, VA.
12. **S.-H. Shim** and T. S. Duffy. Raman spectroscopy of Fe<sub>2</sub>O<sub>3</sub> to 62 GPa: implications for phase transformations and thermodynamic properties. Abstract S38, Eos Transactions American Geophysical Union, 81, Spring Meeting Supplement, 2000.

11. **S.-H. Shim** and T. S. Duffy. Structure and magnetic properties of  $\text{Cr}_2\text{O}_3$  to 61 GPa by Raman spectroscopy and implications for the ruby pressure scale. Abstract S43, Eos Transactions American Geophysical Union, 81, Spring Meeting Supplement, 2000.
10. T. S. Duffy, **S.-H. Shim**, A. Kavner, and G. Shen. Static compression of platinum to 1 Mbar: implications for the pressure-volume-temperature equation of state. Abstract S41, Eos Transactions American Geophysical Union, 81, Spring Meeting Supplement, 2000.
9. T. S. Duffy, A. Kavner, **S.-H. Shim**, and G. Shen. Equation of state and crystal structure of lower mantle and core materials using the laser heated diamond anvil cell. Abstract S49, Eos Transactions American Geophysical Union, 81, Spring Meeting Supplement, 2000.
8. **S.-H. Shim**, T. S. Duffy, and G. Shen. Stability of  $\text{MgSiO}_3$  to 100 GPa and 2500 K. Abstract F742, Eos Transactions American Geophysical Union, 80, Fall Meeting Supplement, 1999.
7. T. S. Duffy, **S.-H. Shim**, and G. Shen. Stability, structure, and P–V–T equation of state of  $\text{CaSiO}_3$  perovskites to 110 GPa and 2500 K. Abstract F928, Eos Transactions American Geophysical Union, 80, Fall Meeting Supplement, 1999.
6. A. Wasserman, **S.-H. Shim**, A. Kavner, and T. S. Duffy. Raman spectroscopy of  $\text{Ni}(\text{OH})_2$  to 22 GPa. Abstract F41, Eos Transactions American Geophysical Union, 80, Fall Meeting Supplement, 1999.
5. **S.-H. Shim**, T. S. Duffy, and G. Shen. P–V–T equation of state of  $\text{MgSiO}_3$  and  $\text{CaSiO}_3$  perovskites to 60 GPa and 2000 K. Abstract F861, Eos Transactions American Geophysical Union, 79, Fall Meeting Supplement, 1998.
4. A. Navrotsky, **S.-H. Shim**, T. R. Gaffney, and J. MacDougall. Chabazite: enthalpy of formation and energetics of hydration. International Zeolite Congress, 1998.
3. **S.-H. Shim**, T. S. Duffy, G. Shen, and D. L. Heinz. Phase transition in cobalt above 18 GPa and 1800 K. Abstract S164, Eos Transactions American Geophysical Union, 79, Spring Meeting Supplement, 1998.
2. **S.-H. Shim**, J. H. Ahn, and S. J. Kim. Quantitative analysis of feldspar minerals using Rietveld refinement method. Annual Meeting of the Mineralogical Society of Korea, 1994.
1. J. H. Ahn, **S.-H. Shim**, and S. J. Kim. Quantitative analysis of perthite using Rietveld refinement method. Annual Meeting of the Mineralogical Society of Korea, 1993.

# Grants

**Tags:** Shim's recent developments are highlighted with the following symbols.

 Solar-system planets and Exoplanets    Technical developments    Educational developments

- 2022/08/15–07/31/2025:** NSF-EAR2153968, Collaborative Research: From Silicate Melts Properties to the Dynamics and Evolution of an Early Basal Magma Ocean. PI: W. Mao (Stanford U.). \$249,976 for Shim at ASU  
- 2022/01/11:** NSF-EAR2140416, Upgrade of the Raman Spectroscopy System at the High-Pressure Lab of Arizona State University. PI: S.-H. Shim. \$85,275; 100% recognition for Shim 
- 2021/10/01–2026/09/30:** NSF-EAR2131833, Facility for Open Research in a Compressed Environment (FORCE) at Arizona State University. PI: K. Leinenweber; co-PI: A. Navrotsky, T. Sharp, D. Smith, and S.-H. Shim. \$13,711,265; 5% recognition for Shim 
- 2021/08/01–2023/07/31:** NSF-AST2108129, Ingassing of Hydrogen in the Interiors of Sub-Neptunes and Gas Giants. PI: S.-H. Shim. \$320,615; 100% recognition for Shim 
- 2020/07/01–2022/06/30:** NSF-AST2005567, Effect of Hydrogen on the Sulfur-rich Martian Core. PI: S.-H. Shim. \$295,000; 100% recognition for Shim 
- 2020/07/01–2022/06/30:** NSF-EAR2019565, Possible Storage of H<sub>2</sub>O in Mantle Ca(Ti,Si)O<sub>3</sub> perovskite. PI: S.-H. Shim. \$279,262; 100% recognition for Shim
- 2019/08/01–2021/07/31:** NSF-EAR1921298, Effect of Hydrogen on the Behaviors of Fe Alloys in the Earth's Outer Core. PI: S.-H. Shim; co-PI: A. Chizmeshya. \$298,952; 80% recognition for Shim
- 2019/06/01–2021/05/31:** NSF-EAR1855624, Cooperative Studies of The Earth's Deep Interior (CSEDI) Collaborative Research: Ultra-High Velocity Zones (UHVZs) at the Core-Mantle Boundary. PI: E. Garnero; co-PI: M. Li and S.-H. Shim. \$544,767; 33% recognition for Shim
- 2018/01/03–2022/01/02:** NASA-80NSSC18K0353, Breaking the Barrier between Ice and Rock – New Mass-Radius Relations for Gas Giant, Icy Giant, Mini-Neptune, and Water World Exoplanets. PI: S.-H. Shim; co-PI: K. Leinenweber and A. Chizmeshya. \$559,951; 40% recognition for Shim 
- 2014/12/31–2020/12/30:** NASA, Exoplanetary Ecosystems: Exploring Life's Detectability on Chemically Diverse Exoplanets. PI: S. Desch; co-PI: S.-H. Shim among others. \$6,097,436; 4% recognition for Shim 
- 2017/06/15–2020/06/15:** NSF-EAR1725094, Calcium in Bridgmanite in the Deep Mantle. PI: S.-H. Shim. \$271,735; 100% recognition for Shim
- 2017:** Stanford Linear Accelerator Center (SLAC) National Accelerator Laboratory, Materials Synthesis for Laser-Driven Shock Wave Experiments at Linac Coherent Light Source (LCLS). PI: S.-H. Shim. \$22,248; 100% recognition for Shim 
- 2016/01/01–2019/12/31:** The Keck Foundation, Water from the Heavens: The Origins of Earth's Hydrogen. PI: P. Buseck; co-PI: S.-H. Shim among others. \$1,500,000; 14% recognition for Shim
- 2014/09/01–2016/08/31:** NSF-EAR1401270, Cooperative Studies of The Earth's Deep Interior (CSEDI) Collaborative Research: Deep Mantle Cycling of Oceanic Crust. PI: E. Garnero; co-PI: A. McNamara and S.-H. Shim. \$818,541; 33% recognition for Shim
- 2013/09/01–2018/08/31:** NSF-FESD-Type I, The Dynamics of Earth System Oxygenation. PI: A. Anbar; co-PI: S.-H. Shim among others. \$3,080,000; 5% recognition for Shim
- 2013/08/01–2016/07/31:** NSF-EAR1321976, Hydration of Dense Polymorphs of Silica in Subducting Slabs. PI: K. Leinenweber; co-PI: Shim. \$312,839; 33% recognition for Shim

**2011/01/01–2015/12/31:** NSF-EAR1301813, The Perovskite to Post-Perovskite Phase Boundary in Mantle Rocks. PI: S.-H. Shim. \$398,149 (\$229,068 transferred to ASU); 100% recognition for Shim

**2010/09/01–2015/08/31:** NSF-EAR1316022, Cooperative Studies of The Earth's Deep Interior (CSEDI) Collaborative Research: Valence State of Iron in the Lower Mantle. PI: S.-H. Shim; co-PI: Morgan. \$330,922 for Shim (\$69,447 transferred to ASU)

**2009/12/15–2014/11/30:** NSF-EAR1316007, Understanding the Complexity near the 660-km Seismic Discontinuity. PI: S.-H. Shim. \$360,281 (\$58,468 transferred to ASU); 100% recognition for Shim

**2008/07/01–2011/06/30:** NSF-EAR0757871, Cooperative Studies of The Earth's Deep Interior (CSEDI) Collaborative Research: Multi-scale Analysis of Mantle Discontinuities using Inverse Scattering of SS Waves and Experimental Mineral Physics. PI: R. van der Hilst; co-PI: S.-H. Shim. \$299,999

**2010/06/01–2011/05/30:** NSF-DMR0819762, CMSE-Initiative 3. S.-H. Shim as a co-PI. \$26,500 for Shim

**2008/01/01–2010/12/31:** NSF-EAR0738655, Equation of State and Phase Boundary of Post-Perovskite. PI: S.-H. Shim. \$259,803; 100% recognition for Shim




**2004/07/01–2008/06/30:** NSF-EAR0337005, In situ Raman Spectroscopy Study for Phase Diagrams of Mantle Minerals at High Pressure and Temperature. PI: S.-H. Shim. \$255,829; 100% recognition for Shim

**2004/03/10–2006/03/09:** NSF-EAR0337156, Acquisition of a Combined Micro-Raman Spectroscopy and Laser Heating System for in situ High Pressure and High Temperature Studies. PI: S.-H. Shim. \$185,244; 100% recognition for Shim










**2004:** Wade Award, Acquisition of a Double Monochromator for Raman Spectroscopy Measurements at High Pressure and Temperature. PI: S.-H. Shim. \$45,000; 100% recognition for Shim

# Courses

**Tags:** Shim's recent developments are highlighted with the following symbols.

 Solar-system planets and Exoplanets     Technical developments     Educational developments

All the courses here are in-person. F: Fall, S: Spring

- 2022F, 2021F, 2020F:** SES230. Coding for Exploration, ASU  
- 2022S, 2018F, 2016F, 2014F:** GLG494/598. Advanced Mineralogy: Crystallography and Spectroscopy, ASU
- 2021S:** SES494/598. Data and Computation, ASU  
- 2020S, 2017F, 2015F:** GLG494/598. Introduction to Mineral Physics, ASU 
- 2019F:** SES130. Coding for Exploration, ASU 
- 2018S:** GLG494/598. Exploring Data with Python, ASU 
- 2017S:** GLG294/598. Python for Earth Science, ASU 
- 2016S, 2013S:** GLG101. Introduction to Geology I (Physical), ASU
- 2015S, 2014S:** GLG305. Dynamic Earth, ASU (co-teach with D. DeVecchio in 2014S)
- 2014F:** GLG591. Archean Geophysics (co-teach with A. Anbar), ASU
- 2014S:** GLG591. Chemical Processes in Earth's Interior, ASU
- 2013F:** GLG598. Planetary Materials, ASU
- 2011S:** 12.591. Hydrogen: from Planetary to Energy Sciences, MIT 
- 2010F:** 12.591. Volatiles in the Earth and Planetary Interiors, MIT 
- 2010S–2007S:** 12.108. Structure of Earth Materials, MIT
- 2009F:** 12.591. The Core-Mantle Boundary, MIT
- 2008F, 2004F:** 12.575. Introduction to Mineral Physics, MIT
- 2007S, 2006F, 2006S:** 12.080. EAPS Undergraduate Seminar, MIT
- 2005F:** 12.571. Deep Water - Geophysical Prospective, MIT
- 2005S:** 12.581. Phase Transitions in the Earth's Interior, MIT
- 2004S:** 12.570. Structure and Dynamics of the Core-Mantle Boundary Region, MIT

# Mentoring

## B.S. Thesis

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**2019:** Britany Kulka, ASU (now Ph.D. student at Oxford University)

**2015:** Shaela Noble, Barrett Honors College, ASU (now Master student at University of California, Davis, Bidstrup Undergraduate Fellow)

**2007:** Caitlin Murphy, MIT (now Senior Policy Analyst at the National Renewable Energy Laboratory in Golden, CO)

## M.S. Thesis

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**2019–2021:** Britany Kulka, ASU (now Ph.D. Student at Oxford University)

**2018–2019:** Jonathan Dolinski, ASU (now Ph.D. Student at Bayreuth University, Germany)

## Ph.D. Thesis

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**2021–present:** Xuehui Wei, ASU (expected for 2026)

**2018–2022:** Harrison Allen-Sutter, ASU

**2017–2021:** Taehyun Kim, Yonsei University

**2014–2020:** Byeongkwan Ko, ASU (now Postdoc at Michigan State University)

**2014–2019:** Huawei Chen, ASU (now Assistant Professor at China University of Geosciences, China)

**2005–2011:** Krystle Catalli, MIT (now Principal Engineer at Apple, Inc)

## Postdoctoral Researchers

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**2022–present:** Taehyun Kim, ASU

**2020–2022:** Suyu Fu, ASU (now Now Japan Society for the Promotion of Science (JSPS) Postdoctoral Fellow. Univ. Tokyo)

**2017–2021:** Hélène Piet, ASU (now Research Scientist at W. L. Gore & Associates)

**2020–2021:** Byeongkwan Ko, ASU (now Postdoc at Michigan State University)

**2017–2019:** Joseph O'Rourke, Exploration Postdoctoral Fellow, ASU (co-advised with Prof. L. Elkins-Tanton; now Assistant Professor at ASU)

**2016–2018:** Cayman Unterborn, Exploration Postdoctoral Fellow, ASU (co-advised with Prof. S. Desch; now Research Associate at ASU)

**2012–2018:** Carole Nisr, ASU (now Professor at Phoenix College)

**2012–2014:** Yu Ye, ASU (now Associate Professor at China University of Geosciences, China)

**2011:** Antonio Buono, MIT (now Research Scientist at ExxonMobil)

**2008–2011:** Brent Grocholski, MIT (now Senior Editor in journal *Science*)

**2006–2007:** Justin Hustoft, MIT (now Assistant Professor at Mount Mary University, WI)



**2004–2006:** Javier Santillán, MIT, Ford Postdoctoral Fellow (now Global CT Manager at Apple, Inc)

**2003–2005:** Sandeep Rekhi, MIT (now Principal Engineer at Apple, Inc)

## **Undergraduate Research Program**

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**I advised all the following undergraduate students for the undergraduate research program in my group.**

**2022–present:** Enzo Carrascal, ASU

**2021–present:** Shradha Ravikumar, Barrett, ASU

**2019:** Robert Rezvani and Ayla Zustra, Barrett, ASU

**2018–2019:** Britany Kulka, ASU (now Ph.D. student at Oxford University)

**2017–2019:** Jacqueline Tappan, ASU (now Staff Hydrogeologist at Leonard Rice Engineers Inc.)

**2017:** Jonathan Dolinski, ASU (now Ph.D. Student at Bayreuth University, Germany)

**2016–2017:** Abigail Weibel, ASU (now Project Manager Associate at ASU)

**2015–2016:** Patrick Kennedy, ASU (now Technologist at Audiolex)

**2015–2016:** Shaela Noble, ASU (now Master student at University of California, Davis)

**2015–2016:** Mark Williamson, ASU

**2009:** Elizabeth George, MIT (now Detector Engineer at European Southern Observatory, Munich, Germany)

**2008:** Michael DeMeo, Leslie C. Patron Undergraduate Research Opportunity Program, MIT (now Application Engineer at Exa Corporation, Detroit, MI)

**2008:** Deidre LaBounty, MIT (now Graduate Student at University of Alaska Fairbanks)

**2007–2008:** Rachel Zucker, Leslie C. Patron Undergraduate Research Opportunity Program, MIT (now Senior Research Scientist at Kernel, CA)

**2006:** Sarah Slotznick, Leslie C. Patron Undergraduate Research Opportunity Program, MIT (now Miller Postdoctoral Fellow, Department of Earth and Planetary Science, University of California, Berkeley)

**2004–2005:** Nicholas Leiby, MIT (now Lead Data Scientist at Kyruus, Alexandria, VA)

## **Visiting Graduate Students**

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**2017–2021:** Taehyun Kim, Visiting Ph.D. Student from Yonsei University, Korea

**2012–2013:** Qian Zhang, Visiting Ph.D. Student from Peking University, China (now Staff Scientist at China University of Geosciences)

## **Thesis Committee Member**

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These students are not directly mentored by Shim. Shim was a committee member for the dissertation.

**2022:** Harrison Allen-Sutter, Qian Yuan (Ph.D.), ASU

**2021:** Jake Hanson (Ph.D.), ASU

**2020:** Hannah Shamloo (Ph.D.), ASU

**2019:** Hongyu Lai (Ph.D.), Shule Yu (Ph.D.), Alyssa Anderson (Ph.D.), Sarah Dillon (M.S.), Emily Garhart (M.S.), and Gabriel Franco (M.S.), ASU  
**2018:** Alejandro Lorenzo (M.S.), ASU  
**2016:** Shkolyar Svetlana (Ph.D.), ASU  
**2015:** Jeffrey Lockridge (Ph.D.) Rebecca Smith (Ph.D.), and Alex Mastrean (B.S.), ASU  
**2014:** Mingming Li (Ph.D.) and Michael Pagano (Ph.D.), ASU  
**2011:** Michael Krawczynski (Ph.D.), and Qin Cao (Ph.D.), and Stephanie Brown (M.S.), MIT  
**2010:** Jay Barr (Ph.D.), MIT  
**2007:** Emily Van Ark (Ph.D.), Guangping Xu (Ph.D.), and Ping Wang (Ph.D.), MIT  
**2006:** Shichun Huang (Ph.D.), MIT

## Graduate Students for Second Comprehensive Exam Project

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SESE at ASU (and also MIT) requires Ph.D. students to carry out with two separate research projects with two different faculty advisors for their comprehensive exams. Their second projects should involve work in substantially different fields. Shim has regular weekly research meetings with the students for at least 1 semester to ensure sufficient progress in their second research projects.

**2022–present:** Leah Shteynman  
**2018–2019:** Emily Garhart and Gabriel Franco, ASU  
**2017–2018:** Jonathan Hoh and Alexandra Pye, ASU  
**2015–2017:** Alyssa Anderson, ASU  
**2008–2012:** Xuefeng Shang and Nathaniel Dixon, MIT  
**2004–2006:** Rosalee Lamm, MIT




## Comprehensive Examination Committees

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**2021–2022:** Sasha Sypkens and Kevin Trinh, ASU  
**2020–2021:** Camerian Millsaps, Saira Hamid, and Aditya Khuller, ASU  
**2019–2020:** Mariah Heck, Qian Yuan, and Harrison Allen-Sutter, ASU  
**2018–2019:** Alexandra Pye, Jonathan Hoh, and Sierra Ferguson, ASU  
**2017–2018:** Hanna Shamloo and Jake Hanson (Chair), ASU  
**2016–2017:** Huawei Chen, Byeongkwan Ko, Kara Brugman, and Alyssa Anderson, ASU  
**2015–2016:** Megan Miller (Chair), Julie Mitchell, and Hongyu Lai, ASU  
**2014–2015:** Luke Probst, Ruirui Han, Jinping Hu (Chair), and Christopher Haberle, ASU  
**2013–2014:** Jeffrey Lockridge and Jinping Hu, ASU  
**2012:** Chen Gu, MIT  
**2009:** Qin Cao (Chair), Nathan Dixon, and Xuefeng Shang, MIT  
**2007:** Krystle Catalli, MIT  
**2006:** Jay Barr and Noah McLean, MIT

# Service


**Tags:** Shim's recent developments are highlighted with the following symbols.

 Solar-system planets and Exoplanets     Technical developments     Educational developments


## University Service

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**2022:** Member of Research Scientist Search Committee, Facility for Open Research in a Compressed Environment (FORCE), ASU

**2021–present:** Member of Steering Committee, Facility for Open Research in a Compressed Environment (FORCE), ASU 

**2019–present:** Member of Steering Committee, Center for Materials of the Universe (MOTU), ASU 

**2019:** Chair of Organizing Committee for Workshop on Materials of the Universe (MOTU), ASU 

**2017–2022:** Member of Materials Governance Board, ASU

## Unit/Department Service at ASU

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**2021–present:** Member of SESE Annual Evaluation committee, SESE, ASU

**2020–present:** Member of SESE Exploration Postdoctoral scholar committee, SESE, ASU

**2019–2020:** Member of Thermochemistry Faculty Search Committee, School of Molecular Sciences (SMS), ASU

**2019–2020:** Member of Faculty Annual Evaluation Committee, SESE, ASU

**2016–2017:** Member of Geophysics Faculty Search Committee, SESE, ASU

**2016–2017:** Member of Geochemistry Faculty Search Committee, SESE, ASU

**2016:** Chair of Graduate Student Recruiting Committee, SESE, ASU

**2013–2016:** Member of Graduate Student Recruiting Committee, SESE, ASU

**2012–2013:** Chair of Geophysics Faculty Search Committee, SESE, ASU

**2012:** Member of Award Committee, SESE, ASU

## Unit/Department Service at MIT

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**2009–2010:** Member of Graduate Admissions Committee, EAPS, MIT

**2008–2009:** Member of Graduate Committee, EAPS, MIT

**2006–2007:** Chair of Independent Activities Period Educational Program Committee, EAPS, MIT


**2007:** Member of Promotion Committee for Chatterjee to Senior Research Scientist, EAPS, MIT

**2006:** Member of Theoretical Geophysics Faculty Search Committee, EAPS, MIT

**2003–2006:** Member of Graduate Admissions Committee, EAPS, MIT

## Non-ASU Professional Service

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**2022:** Organizer, Town hall meeting for Facility for Open Research in a Compressed Environment 

(FORCE), 2022


**2019:** Organizer, ED52A - Linking Education and Research with Jupyter, Fall American Geophysical Union meeting, San Francisco, December 9–13, 2019 

**2019:** External Reviewer for Geophysics Faculty Search, Yonsei University, Korea

**2018–present:** Member, NExSS (Nexus for Exoplanet System Science) Steering Committee, NASA 

**2017:** Organizing Committee Chair, COMPRES Workshop: Software Toolkit, Consortium for Materials Properties Research in Earth Sciences (COMPRES) Annual Meeting, Hyatt Regency Tamaya Resort, Santa Ana Pueblo, NM, July 9–12, 2017 

**2017:** Member, Review panel for the Cooperative Studies of the Earth's Deep Interior (CSEDI) program, National Science Foundation (NSF)

**2015:** Organizing Committee Chair, Workshop for US Large Multi-Anvil Press Facility (LMAPF), Consortium for Materials Properties Research in Earth Sciences (COMPRES) Annual Meeting, Colorado Springs, CO, July 6, 2015 

**2015–2018:** Member, Facilities Committee, Consortium for Materials Properties Research in Earth Sciences (COMPRES)

**2013–2015:** Editor, Geophysical Journal International

**2013–2020:** Member, Advanced Photon Source Proposal Review Panel for High Pressure Science, Argonne National Laboratory

**2010–2015:** Member, Executive Committee, Mineral and Rock Physics Focus Group, American Geophysical Union (AGU)

**2010–2014:** Vice Chair, Subcommittee for Spectroscopy, Diffraction, and New Instrumentations in Mineral Physics, Commission of Physics of Minerals, International Mineralogical Association (IMA)

**2010:** Consulting editor, Odyssey - Adventures in Science, Science Magazine for Middle Schoolers, “That Rocks!” issue

**2004–2010:** Member, Infrastructure Development Committee, Consortium for Materials Properties Research in Earth Sciences (COMPRES)

**2008:** Member, International Organizing Committee, 4th Asian Conference in High Pressure Research, Seoul, Korea

**2004–2006:** Associate Editor, American Mineralogist

## Journal Article Review

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Nature, Science, Nature Geoscience, Science Advance, Geophysical Research letters, Proceedings of the National Academy of Sciences, Journal of Geophysical Research, American Mineralogist, Earth and Planetary Science Letters, Physics of the Earth and Planetary Interiors, Physical Review, Journal of Solid State Chemistry

## Grant Proposal Review

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National Aeronautics and Space Administration (NASA) Exoplanet Research Program, National Science Foundation (NSF) Geophysics, National Science Foundation (NSF) Geochemistry and Petrology, National Science Foundation (NSF) Earth Sciences: Instrumentation and Facilities, National Science Foundation (NSF) Materials Research, European Science Foundation EuroMinSc