

# Taehyun Kim (T. Kim) - Curriculum Vitae

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Affiliation: School of Earth and Space Exploration, Arizona State University

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## Education

- 2017. 05. - 2022. 02.

Visiting student, School of Earth and Space Exploration, Arizona State University, Tempe, USA.

- 2015. 09. - 2022. 02.

Ph.D. in Geological science. Graduate program, Department of Earth System Sciences, Yonsei University, Seoul, South Korea.

- 2010. 03. - 2015. 08.

Bachelor of Science, Department of Earth System Sciences, Yonsei University, Seoul, South Korea.

## Employment

- 2022. 05. - present

Postdoctoral research scholar, School of Earth and Space Exploration, Arizona State University, Tempe, USA.

- 2022. 03. - 2022. 04.

Postdoctoral researcher, Department of Earth System Sciences, Yonsei University, Seoul, South Korea.

## Scientific and/or Technical Expertise

- **High-pressure** : I conducted research using diamond-anvil cells (DAC) at Yonsei University, Arizona State University (ASU), synchrotron facilities (APS, ALS, PLS-II, SSRL, DESY, and PAL-XFEL). I conducted research using a large-volume press (LVP) instrument at ASU.
- **High-temperature** : I conducted research using (infrared) laser heating systems at ASU, APS, and DESY. I built a new laser heating system at Yonsei University. I have conducted research using a resistive heating system at DESY. I have conducted pulsed-laser shock experiments at PAL-XFEL.
- **Synchrotron X-ray diffraction** : I conducted the synchrotron X-ray diffraction (XRD) experiments at Advanced Photon Source (APS; USA), Advanced Light Source (ALS; USA), Pohang Light Source-II (PLS-II; South Korea), Stanford Synchrotron Radiation Light Source (SSRL; USA), Deutsches Elektronen-Synchrotron (DESY; Germany), and Pohang Accelerator Laboratory X-ray Free Electron Laser (PAL-XFEL; South Korea).
- **Synchrotron X-ray fluorescence** : I conducted the synchrotron X-ray fluorescence (XRF) experiments at SSRL.
- **Synchrotron X-ray tomography** : I conducted the synchrotron X-ray tomography at PLS-II.
- **Synchrotron infrared spectroscopy** : I conducted the synchrotron infrared spectroscopy experiments at PLS-II, and National Synchrotron Light Source II (NSLS-II; USA).
- **Raman spectroscopy** : For samples in laser-heated diamond-anvil cell, I conducted research using the Raman spectroscopic systems at ASU, and APS.
- **Electron microscopy** : For chemical analysis, I conducted research using focused-ion beam instrument combined with scanning electron microscope at ASU and Yonsei University. I have also conducted research using transmission electron microscope instruments at ASU and Yonsei University.
- **High-pressure gas-loading** : I conducted research using the high-pressure gas-loading systems at ASU, APS, and DESY. I used H<sub>2</sub>, Argon-H<sub>2</sub> mixture, and Argon gases for the DAC experiments.

- **Neutron diffraction and tomography** : I conducted the neutron diffraction and tomography at Australian Nuclear Science and Technology Organisation (ANSTO, Australia).

## Research Interests

- **Mineral physics**

Planetary materials at extreme conditions

Thermodynamic properties of planetary materials at extreme conditions

Studying under-explored pressure-temperature-composition diagrams (e.g., Fe-H-He and H<sub>2</sub>O-Ne)

Chemical interaction of volatile elements and silicates (and/or metals)

Understanding chemical properties (e.g., partitioning) of stable isotopes at extreme conditions

- **Geophysics**

The deep interior of Earth

Rock and volatile elements cycle in the deep interior of the Earth

Understanding processes at the core-mantle boundary conditions

- **Planetary sciences**

Understanding early stage of planet evolution

Chemical evolution of minor elements (e.g., some isotopes) in the early and present terrestrial planets

Deep interior of ice and gas giants in the solar system

Deep interior of sub-Neptunes and super-Earths in the exoplanetary systems

## Academic performance

### Publications

<Comments and roles are below of each publication>

#### In preparation

**18. Taehyun Kim\***, Stella Chariton, Vitali Prakapenka, Yongjae Lee, and Sang-Heon Shim\*. *Chemical reactions between (Mg,Fe)O and H<sub>2</sub>O at multi-megabar conditions: its implications on the deep interior of large water-rich planets.*

<This manuscript will be submitted to a scientific journal in early 2024>

**17. Taehyun Kim\***, Stella Chariton, Vitali Prakapenka, Young-Jay Ryu, Shize Yang, and Sang-Heon Shim\*. *Effect of H<sub>2</sub>-to-H<sub>2</sub>O ratio on the stability of silicates in sub-Neptune exoplanets.*

<This manuscript will be submitted to a scientific journal in 2023>

**16. Taehyun Kim\***, Eran Greenberg, Stella Chariton, Vitali Prakapenka, Sang-Heon Shim\*, and Yongjae Lee\*. *Melting of hydrous pyrolite and its implication for the low seismic velocity zones in the lowermost mantle.*

<This manuscript will be submitted to a scientific journal in 2023>

#### In review or in revision

**15.** Jeongmin Lee, **Taehyun Kim**, Stella Chariton, Vitali Prakapenka, Nico Giordano, Huijeong Hwang, and Yongjae Lee\*. *In-situ high-pressure and high-temperature study of the Fe-S-O-H system: An implication for the thermal evolution of the Martian core.*

<I performed laser-heated DAC experiment. In review at Proc. Natl. Acad. Sci. U.S.A.>

**14.** Jinhyuk Choi, Rachel J. Husband, Huijeong Hwang, **Taehyun Kim**, Yoonah Bang, Seohee Yun, Jeongmin Lee, Heehyeon Sim, Sangsoo Kim, Daewoong Nam, Boknam Chae, Hanns-Peter Liermann, Yongjae Lee\*. *Oxidation of iron by giant impact and its implication on the formation of reduced atmosphere in the early Earth.*

<I performed laser-shock and laser-heated DAC experiments. In 2<sup>nd</sup> round review at Sci. Adv.>

### Published Articles (including in press)

**13. Taehyun Kim\***, Xuehui Wei, Stella Chariton, Vitali Prakapenka, Young-Jay Ryu, Shize Yang, and Sang-Heon Shim\*. *Stability of hydrides in sub-Neptune exoplanets with thick hydrogen-rich atmospheres.*

<I led the research project. This article is currently in press at Proc. Natl. Acad. Sci. U.S.A.>

**12. Taehyun Kim**, Joseph G. O'Rourke, Jeongmin Lee, Stella Chariton, Vitali Prakapenka, Rachel J. Husband, Nico Giordano, Hanns-Peter Liermann, Sang-Heon Shim\*, Yongjae Lee\*. *A hydrogen-enriched layer in the topmost outer core sourced from deeply subducted water.*

<I led the research project. This article is currently in press at Nat. Geosci.> (preprint, <https://www.researchsquare.com/article/rs-1425697/v1>)

**11. Taehyun Kim**, Stella Chariton, Vitali Prakapenka, Anna Pakhomova, Hanns-Peter Liermann, Zhenxian Liu, Sergio Speziale, Sang-Heon Shim\*, and Yongjae Lee\*. *Atomic-scale mixing between MgO and H<sub>2</sub>O in the deep interiors of water-rich planets.* Nature Astronomy 5, August 2021. (doi.org/10.1038/s41550-021-01368-2)

<I led the research project. The article was highlighted by Nat. Astron.; doi.org/10.1038/s41550-021-01421-0>

**10. Rachel J. Husband\***, R. Stewart McWilliams, Edward J. Pace, Amy L. Coleman, Huijeong Hwang, Jinhyuk Choi, **Taehyun Kim**, Gil Chan Hwang, Orianna B. Ball, Sae Hwan Chun, Daewoong Nam, Sangsoo Kim, Hyunchoe Cynn, Vitali B. Prakapenka, Sang-Heon Shim, Sven Toileikis, Malcolm I. McMahon, Yongjae Lee, and Hanns-Peter Liermann. *X-ray free electron laser heating of water and gold at high static pressure.* Communications Materials 2, June 2021. (doi.org/10.1038/s43246-021-00158-7)

<I measured XRD data during PAL-XFEL beamtime>

**9. Huijeong Hwang**, **Taehyun Kim**, Hyunchoe Cynn, Thomas Vogt, Rachel J. Husband, Karen Appel, Carsten Baehtz, Orianna B. Ball, Marzena A. Baron, Richard Briggs, Maxim Bykov, Elena Bykova, Valerio Cerantola, Julien Chantel, Amy L. Coleman, Dana Dattlebaum, Leora E. Dresselhaus-Marais, Jon H. Eggert, Lars Ehm, William J. Evans, Guillaume Fiquet, Mungo Frost, Konstantin Glazyrin, Alexander F. Goncharov, Zsolt Jenei, Jaeyong Kim, Zuzana Konôpková, Jona Mainberger, Mikako Makita, Hauke Marquardt, Emma E. McBride, James D. McHardy, Sébastien Merkel, Guillaume Morard, Earl F. O'Bannon, III, Christoph

Otzen, Edward J. Pace, Alexander Pelka, Charles M. Pépin, Jeffrey S. Pigott, Vitali B. Prakapenka, Clemens Prescher, Ronald Redmer, Sergio Speziale, Georg Spiekermann, Cornelius Strohm, Blake T. Sturtevant, Nenad Velisavljevic, Max Wilke, Choong-Shik Yoo, Ulf Zastrau, Hanns-Peter Liermann, Malcolm I. McMahon, R. Stewart McWilliams\*, and Yongjae Lee\*. *X-ray Free Electron Laser-Induced Synthesis of  $\epsilon$ -Iron Nitride at High Pressures*. *The Journal of Physical Chemistry Letters* 12, March 2021. (doi.org/10.1021/acs.jpcclett.1c00150)

<I performed transmission electron microscopy (TEM) measurements for the recovered samples>

8. Yoonah Bang, Huijeong Hwang, **Taehyun Kim**, Hyunchoe Cynn, Yong Park, Haemyeong Jung, Changyong Park, Dmitry Popov, Vitali B. Prakapenka, Lin Wang, Hanns-Peter Liermann, Tetsuo Irifune, Ho-Kwang Mao, and Yongjae Lee\*. *The stability of subducted glaucophane with the Earth's secular cooling*. *Nature Communications* 12, March 2021. (doi.org/10.1038/s41467-021-21746-8)

<I performed laser-heated DAC experiments for the project>

7. Huawei Chen\*, Sheng-Yi Xie, Byeongkwan Ko, **Taehyun Kim**, Carole Nisr, Vitali Prakapenka, Eran Greenberg, Dongzhou Zhang, Wenli Bi, Alp E. Ercan, Yongjae Lee, and Sang-Heon Shim\*. *A new hydrous iron oxide phase stable at mid-mantle pressures*. *Earth and Planetary Science Letters* 550, November 2020. (doi.org/10.1016/j.epsl.2020.116551)

<I collected some XRD data for the project>

6. **Taehyun Kim**, Byeongkwan Ko, Eran Greenberg, Vitali Prakapenka, Sang-Heon Shim\*, and Yongjae Lee\*. *Low Melting Temperature of Anhydrous Mantle Materials at the Core-Mantle Boundary*. *Geophysical Research Letters* 47, October 2020. (doi.org/10.1029/2020GL089345)

<I led the research project>

5. H. Hwang, E. Galtier, H. Cynn, I. Eom, S. H. Chun, Y. Bang, G. C. Hwang, J. Choi, **T. Kim**, M. Kong, S. Kwon, K. Kang, H. J. Lee, C. Park, J. I. Lee, Yongmoon Lee, W. Yang, S.-H. Shim, T. Vogt, Sangsoo Kim, J. Park, Sunam Kim, D. Nam, J. H. Lee, H. Hyun, M. Kim, T.-Y. Koo, C.-C. Kao, T. Sekine, and Yongjae Lee\*. *Subnanosecond phase transition dynamics in laser-shocked iron*. *Science Advances* 6, June 2020. (doi.org/10.1126/sciadv.aaz5132)

<I prepared samples and measured XRD data for the project>

4. Edward J. Pace, Amy L. Coleman, Rachel J. Husband, Huijeong Hwang, Jinhyuk Choi,

**Taehyun Kim**, Gilchan Hwang, Sae Hwan Chun, Daewoong Nam, Sangsoo Kim, Orianna B. Ball, Hanns-Peter Liermann, Malcolm I. McMahon, Yongjae Lee, and R. Stewart McWilliams\*. *Intense Reactivity in Sulfur–Hydrogen Mixtures at High Pressure under X-ray Irradiation*. *The Journal of Physical Chemistry Letters* 11, February 2020. (doi.org/10.1021/acs.jpcclett.9b03797)

<I performed a few XRD experiments for the project>

3. Xin Li, Ye Yuan, Jinbo Zhang, **Taehyun Kim**, Dongzhou Zhang, Ke Yang, Yongjae Lee, and Lin Wang\*. *Pressure-induced photoluminescence of MgO*. *Journal of Physics: Condensed Matter* 30, May 2018. (doi.org/10.1088/1361-648X/aabb40)

<I performed some chemical analysis for the project>

2. **Taehyun Kim**, Yongjae Lee\*, and Yuong-Nam Lee. *Fluorapatite diagenetic differences between Cretaceous skeletal fossils of Mongolia and Korea*. *Palaeogeography, Palaeoclimatology, Palaeoecology* 490, January 2018. (doi.org/10.1016/j.palaeo.2017.11.047)

<I performed XRD, X-ray fluorescence, and X-ray computed tomography (CT) for fossils excavated at South Korea and Mongolia>

1. Yongjae Lee\*, Yongmoon Lee, Donghoon Seoung, Jun-Hyuk Im, Hee-Jung Hwang, **Taehyun Kim**, Dan Liu, Zhenxian Liu, Seung Yeop Lee, Chi-Chang Kao, and Thomas Vogt. *Immobilization of Large, Aliovalent Cations in the Small-Pore Zeolite K-Natrolite by Means of Pressure*. *Angewandte Chemie International Edition* 51, 2012. (doi.org/10.1002/anie.201201045)

<I synthesized some samples>

## Conference abstracts

### Contributed Conference Presentations

18. **Taehyun Kim**, Xuehui Wei, Stella Chariton, Vitali Prakapenka, Young-Jay Ryu, Shize Yang, and Sang-Heon Shim. *Formation of Mg-hydrides and Water from Reaction between MgO and Hydrogen and Implication for Sub-Neptune Exoplanets*. AGU Fall Meeting 2023, USA. December 2023. (has been assigned; D151A-07)

17. **Taehyun Kim**, Stella Chariton, Vitali Prakapenka, Young-Jay Ryu, Shize Yang, and

Sang-Heon Shim. *Effect of H<sub>2</sub>-to-H<sub>2</sub>O ratio on the stability of silicates in sub-Neptune exoplanets*. AGU Fall Meeting 2023, USA. December 2023. (has been assigned; P23F-3106)

16. Sang-Heon Shim, Harrison W Horn, **Taehyun Kim**, Helene Piet, Sergio Speziale, Yongjae Lee, Stella Chariton, and Vitali Prakapenka. *High-Pressure Chemistry Linking Dry and Wet Planets*. 23rd Biennial Conference of the APS Topical Group on Shock Compression of Condensed Matter, Chicago. June 2023.

15. **Taehyun Kim**, Joseph G O'Rourke, Jeongmin Lee, Stella Chariton, Vitali Prakapenka, Rachel Husband, Nico Giordano, Hanns-Peter Liermann, Yongjae Lee, and Sang-Heon Shim. *Possible link between deeply subducted water and the E' layer*. AGU Fall Meeting 2022, USA. December 2022. (Oral presentation)

14. **Taehyun Kim**, Eran Greenberg, Vitali Prakapenka, Yongjae Lee, and Sang-Heon Shim. *Melting behaviors of hydrous pyrolite in the lower mantle*. AGU Fall Meeting 2022, USA. December 2022. (Oral presentation)

13. **Taehyun Kim**, Xuehui Wei, Stella Chariton, Vitali Prakapenka, and Sang-Heon Shim. *Impact of the H<sub>2</sub>/H<sub>2</sub>O ratio on the internal structure of Uranus, Neptune, and sub-Neptune exoplanets*. Exoplanets in Our Backyard 2, USA. November 2022. (Oral presentation)

12. **Taehyun Kim**, Yongjae Lee, Stella Chariton, Vitali Prakapenka, Anna Pakhomova, Hanns-Peter Liermann, Zhenxian Liu, Sergio Speziale, and Sang-Heon Shim. *Solubility of MgO in H<sub>2</sub>O-H<sub>2</sub> at high pressures and its implications for large water-rich planets*. 54<sup>th</sup> Annual DPS (Division for Planetary Sciences) Meeting, Canada. October 2022. (Oral presentation)

11. Sang-Heon Shim, Helene Piet, Suyu Fu, Byeongkwan Ko, **Taehyun Kim**, Yongjae Lee, Vitali Prakapenka, and Stella Chariton. *Impacts of Hydrogen on the Chemistry and Structure of Rocky Planets Cores*. AGU Fall Meeting 2021, New Orleans. December 2021.

10. **Taehyun Kim**, Stella Chariton, Vitali Prakapenka, Anna Pakhomova, Hanns-Peter Liermann, Zhenxian Liu, Sergio Speziale, Sang-Heon Shim, and Yongjae Lee. *Atomic Scale Mixing between MgO and H<sub>2</sub>O in the Deep Interiors of Water-rich Planets*. Europlanet Science Congress 2021 (Session: Ice Giant System Science and Exploration), Germany. September 2021 (Virtual meeting). (Oral presentation)

9. **Taehyun Kim**, Jeongmin Lee, Stella Chariton, Vitali Prakapenka, Rachel Husband, Nico Giordano, Hanns-Peter Liermann, Sang-Heon Shim, and Yongjae Lee. *Water may limit silicon amount in the Earth's core*. 2021 COMPRES Annual Meeting, USA. August 2021



(Virtual meeting). (Oral presentation)

8. Sang-Heon Shim, Carole Nisr, **Taehyun Kim**, Yongjae Lee, Andrew Chizmeshya, Kurt Leinenweber, Stella Chariton, Vitali Prakapenka, Sergio Speziale, Zhenxian Liu, and Hanns-Peter Liermann. *Mineral-Water Reaction at High Pressures—Implications for Uranus and Neptune*. 52nd Lunar and Planetary Science Conference, USA. March 2021.

7. **Taehyun Kim**, Stella Chariton, Vitali Prakapenka, Anna Pakhomova, Hanns-Peter Liermann, Zhenxian Liu, Sergio Speziale, Sang-Heon Shim, and Yongjae Lee. *Atomic Scale Mixing between (Mg,Fe)O and H<sub>2</sub>O in the Deep Interiors of Water-rich Planets*. DESY Photon Science Users' Meeting 2021 (Session: Status and research highlights of the ECB (P02.2) at PETRA III), Germany. January 2021 (Virtual meeting). (Oral presentation)

6. Britany Kulka, **Taehyun Kim**, Jeongmin Lee, Stella Chariton, Vitali Prakapenka, Yongjae Lee, and Sang-Heon Shim. *Possible control of redox conditions in the laser-heated diamond-anvil cell*. AGU Fall Meeting 2020, USA. December 2020.

5. Byeongkwan Ko, **Taehyun Kim**, Eran Greenberg, Vitali Prakapenka, Yongjae Lee, Sang-Heon Shim. *Temperature-dependent Solubility of Uranium in Silicate Perovskites in the Earth's Lower Mantle*. 2020 COMPRES Annual Meeting, USA. August 2020.

4. **Taehyun Kim**, Sang-Heon Shim, Vitali Prakapenka, Hanns-Peter Liermann, Sergio Speziale, and Yongjae Lee. *High Solubility of Mg in H<sub>2</sub>O at High Pressures and its Implications for the Interiors of Water-rich Planets*. Exoplanets in Our Backyard: Solar System and Exoplanet Synergies on Planetary Formation, Evolution, and Habitability Workshop, USA. February 2020. (Poster presentation)

3. Yoonah Bang, Huijeong Hwang, **Taehyun Kim**, Hyunchoe Cynn, Haemyeong Jung, Changyong Park, Dmitry Popov, Vitali B. Prakapenka, Hanns-Peter Liermann, Lin Wang, Tetsuo Irifune, Ho-Kwang Mao, and Yongjae Lee. *The stability of subducted glaucophane with the Earth's secular cooling*. AGU Fall Meeting 2019, USA. December 2019.

2. **Taehyun Kim**, Sang-Heon Shim, Byeongkwan Ko, Eran Greenberg, Vitali Prakapenka, and Yongjae Lee. *Low Melting Temperatures of Anhydrous and Hydrous Mantle Materials at the Core-Mantle Boundary*. AGU Fall Meeting 2019, USA. December 2019. (Poster presentation)

1. **Taehyun Kim**, Youngnam Lee, and Yongjae Lee. *Comparative mineralogical and geochemical investigation of fossils from Mongolia and Korea*. Goldschmidt, Japan. August 2016. (Poster presentation)

## **Service**

### **Academic service**

Reviewer for Scientific Journals : Earth and Planetary Science Letters, Progress in Earth and Planetary Science, Nature Astronomy

Reviewer for Proposal : National Science Foundation

Committee of the ASU Geophysical Seminar Series (2023–present)

### **Military service**

Republic of Korea Defense Intelligence Command (KDIC), South Korea (2011–2013)

## **Teaching**

### **Teaching Assistant**

2016 Fall      ESS8509-01, Research frontiers in Earth System Sciences, Yonsei University

2016 Spring    ESS4126-01, Senior Thesis\*, Yonsei University

\*Guided undergraduate students in the Earth System Sciences through research and writing for graduation thesis.

## **Honors / Scholarships**

2022            Excellent Academic Paper Award, Yonsei University.

2017 Fall      Graduate student scholarship, Brain Korea 21 Plus, Yonsei University

2016 Fall      Graduate student scholarship, Brain Korea 21 Plus, Yonsei University

2016 Spring   Graduate student scholarship, Brain Korea 21 Plus, Yonsei University

2011 Fall      Undergraduate student Merit scholarship, Yonsei University