

# Qingyang Hu

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## Professional Experience

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**Center for High Pressure Science and Technology Advanced Research, Beijing** 2017 – current  
*Staff Scientist*

- Independent PI managing a research group.
- Building a laboratory dedicated for high-pressure mineral chemistry by combining x-ray probes, Raman, laser heating and diamond anvil cell.

**Department of Geological Sciences, Stanford University, Stanford, CA** 2016 - 2017  
*Postdoctoral Researcher*

- Proposed and confirmed the hypothesis of mantle oxygen reservoir based on experimental findings of oxygen-rich mineral phases like  $\text{FeO}_2$  and  $\text{Fe}_4\text{O}_7$ .
- Redefine the iron-water reaction at core-mantle boundary conditions.
- Established new theories about the separation of oxygen-hydrogen cycling at the lowermost mantle with publications in world's leading journals.

**Geophysical Laboratory, Carnegie Institution of Washington, Washington, DC.** 2014 - 2016  
*Postdoctoral Associate*

- Found a new iron oxide  $\text{FeO}_2$  that can explain geological events like the Great Oxidation Event.
- Advanced experiment protocols to directly observe mineral chemistry between iron-oxides (e.g.  $\text{FeO}$ ,  $\text{Fe}_2\text{O}_3$ ) and water under the conditions of the lower mantle.
- Delivered invited oral presentations at international conferences like AGU and Goldschmidt.

**Department of Physics and Astronomy, George Mason University, Fairfax, VA** 2009 - 2014  
*Research Assistant*

- Found the metastable transition of silica by the use of single-crystal crystallography.
- Modelled the free-energy surface of silica polymorphs using first-principles molecular dynamics.
- Developed python-based codes for visualizing crystals and analyzing x-ray data.
- Publish over 10 peer-reviewed articles in field's top journals.

## Education

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**Ph.D. in Computational Materials Science**  
*George Mason University, Fairfax VA, USA, December 2014*

**B.S. in Optical Science and Engineering,**  
*Beijing Jiaotong University, Beijing, China, June 2009*

## Memberships

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- 2019- Member of European Geosciences Union, Germany.
- 2019- Member of Mineralogical Society of America, U.S.A.
- 2013- Member of American Physics Society, U.S.A.
- 2013- Member of American Geophysical Union, U.S.A

## Award

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- 2017 Top 10 Up-and-Coming Young Scientist, the Knowledge Magazine, China
- 2016 Outstanding Paper for Young Scientist Award, Chinese High-Pressure Science Conference, *China*
- 2015 IUCr Young Scientist Award, International Union of Crystallography (Geophysics)
- 2015 Award for Outstanding CSI Dissertation, George Mason University, *Fairfax, VA*
- 2012 Carnegie Predoctoral Fellowship, Carnegie Institution of Washington, *Washington, DC*

## Conference Talks

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- 2020 **Hu, Q.** “Ionization of H in iron oxy-hydroxide”. APS March Meeting, *Denver, CO, U.S.A.*
- 2019 **Hu, Q.**, Liu, J., Mao, H.-K. and Mao, W.L. “Water Mineral chemistry in Earth’s lower mantle”. AGU Fall Meeting, *San Francisco, CA, U.S.A.*
- 2018 **Hu, Q.**, Zhu, S., Liu, J. and Zhu, Q. “A mechanism for oxygen concentration changes in Fe<sub>2</sub>O<sub>3</sub> and FeO<sub>2</sub>”. AGU Fall Meeting, *San Francisco, CA, U.S.A.*
- 2018 **Hu, Q.**, “Mineralogy and redox in Earth’s lower mantle”, *Invited*, Deep Volatile, Energy & Environments Summit, *Shanghai, China.*
- 2017 **Hu, Q.**, Zhu, S., Mao, W.L., Mao, H.-K. and Sheng, H. “Dehydrogenation Mechanism and Phase Transition Kinetics in High-pressure FeO<sub>2</sub>H”, AGU Fall Meeting, *New Orleans, CA, U.S.A.*
- 2017 **Hu, Q.**, Kim, D. Y., Liu, J., Yang, W., Meng, Y., Yang, L., Mao, W. L. and Mao, H.-K., “Formation of FeO<sub>2</sub> at high pressure and Earth’s oxygen cycling”, *Invited*, The 26<sup>th</sup> International Conference on High Pressure Science and Technology, *Beijing, China.*
- 2017 **Hu, Q.**, Mao, H.-K., Mao, W.L., Discovery of pyrite-structured FeO<sub>2</sub> at high pressure, American Physics Society March Meeting, *New Orleans, LA, U.S.A.*
- 2016 **Hu, Q.**, Kim, D. Y., Yang, W., Yang, L., Meng, Y., Zhang, L., Mao, H.-K., “Synthesis of FeO<sub>2</sub> and the Fe-O-H ternary system in lower mantle”. *Invited*, American Geophysical Union Fall Meeting, *San Francisco, CA, U.S.A.*
- 2016 **Hu, Q.** and Mao, H.-K., “Phase transitions in the Fe-O-H ternary system at high pressure and high temperature”, *Invited*, Frolic Goats Workshop on High Pressure Diffraction, *Poznań, Poland.*
- 2015 **Hu, Q.** “Polymorphic Phase Transition Mechanism in Compressed Coesite”, Materials Research Society, *Boston, MA, U.S.A.*

## Publications (2012/1-2020/1)

### 2020

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1. Lin, Y.\*, Hu, Q.\*, Meng, Y., Walter, M. and Mao, H.-K.\*, Evidence for the stability of ultrahydrous stishovite in Earth's lower mantle. *Proc. Nat. Acad. Sci. U.S.A.* 117, 184-189 (2020).

### 2019

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2. Liu, J., Hu, Q.\*, Bi, W., Yang, L., Xiao, Y., Chow, P., Meng, Y., Prakapenka, V.B., Mao, H.-K.\* and Mao, W. L\*. Altered chemistry of oxygen and iron under deep Earth conditions. *Nat. Commun.* 10, 153 (2019).
3. Zhuang, Y., Cui, Z., Zhang, D., Liu, J., Tao, R. and Hu, Q.\* Experimental Evidence for Partially Dehydrogenated  $\epsilon$ -FeOOH. *Crystals*, 9, 356 (2019).
4. Zhu, S., Liu, J., Hu, Q.\*, Mao, W. L., Meng, Y., Zhang, D., Mao, H.-K. and Zhu, Q.\* Structure-controlled oxygen concentration in Fe<sub>2</sub>O<sub>3</sub> and FeO<sub>2</sub>. *Inorg. Chem.* 58, 5476-5382 (2019).
5. Jang, B.G., Liu, J., Hu, Q., Haule, K., Mao, H.-K., Mao, W.L., Kim, D.Y. and Shim, J.H. Electronic spin transition in FeO<sub>2</sub>: Evidence for Fe(II) with peroxide O<sup>2-</sup>. *Phys. Rev. B* 100, 014418 (2019).
6. Mao, H.-K., Ding, Y., Kim, D.Y., Hu, Q., Liu, J., Yang, L., Yang, W., Zhang, L. and Mao, W.L. Global scale uniformitarianism and catastrophism dictated by crust-to-core volatile cycles. *Acta. Geol. Sin.-Engl.*, 93, 8-8 (2019).
7. Zhang, G., Zhang, Q., Hu, Q., Wang B. and Yang W., Giant enhancements in electronic transport and photoelectric properties of bismuth oxysulfide by pressure-driven 2D-3D structural reconstruction. *J. Mater. Chem. A*, 7, 4019-4025 (2019).

### 2018

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8. Tang, H., Wan, B., Gao, B., Muraba, Y., Qin, Q., Yan, B., Chen, P., Hu, Q., *et al.* Metal-to-semiconductor transition and electronic dimensionality reduction of Ca<sub>2</sub>N electride under pressure. *Adv. Sci.* 5, 1800666 (2018).
9. Liu, G., Gong, J., Kong, L., Schaller R. D., Hu, Q., *et al.* Isothermal pressure-derived metastable states in 2D hybrid perovskites showing enduring bandgap narrowing. *Proc. Nat. Acad. Sci. U.S.A.* 115, 8076-8081 (2018).
10. Tang, H., Yuan, X., Yu, P., Hu, Q., *et al.* Revealing the formation mechanism of ultrahard nano twinned diamond from onion carbon. *Carbon*, 129, 159-167 (2018).

### 2017

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11. Hu, Q., Shu, J.-F., Yang, W., Park, C., Chen, M. W., Fujita, T., Mao, H.-K. and Sheng, H. W. Stability limits and transformation pathways of quartz under high pressure. *Phys. Rev. B*, 95, 104112 (2017).
12. Hu, Q., Kim, D. Y., Liu, J., Meng, Y., Yang, L., Zhang, D., Mao, W. and Mao H.-K. Dehydrogenation of goethite in Earth's deep lower mantle. *Proc. Nat. Acad. Sci. U.S.A.* 114, 1498-1501 (2017).
13. Liu, J., Hu, Q., Kim, D. Y., Wu, Z., Wang, W., Xiao, Y., Paul, C., Meng, Y., Prakapenka, V. B., Mao, H.-K. and Mao, W. L., Hydrogen-bearing iron peroxide and the origin of ultralow-velocity zones. *Nature* 551, 494-497 (2017).
14. Zhu, S., Hu, Q.\*, Mao, L.W., Mao, H.-K., and Sheng, H. Hydrogen-bond symmetrization breakdown and dehydrogenation in compressed FeO<sub>2</sub>H. *J. Am. Chem. Soc.* 139, 12129-12132 (2017).
15. Mao, H.-K., Hu, Q., Yang, L., Liu, J., Kim, D. Y., Meng, Y., Zhang, L., Prakapenka, V. B., Yang, W. and Mao, W. L. When water meets iron at Earth's core-mantle boundary. *Natl. Sci., Rev.* 4, 870-878 (2017).

16. Liu, G., Kong, L., Guo, P., Stoumpos, C. C., Hu, Q., Liu, Z., Cai, Z., Gosztola, D. J., Mao, H.-K., Kanatzidis, M. G. and Schaller, R. D., Two-regimes of bandgap redshift and partial ambient retention in pressure treated two-dimensional perovskites. *ACS Energy Lett.* 2, 2518-2524 (2017).
17. Yu, Z., Wu, W., Lu, P., Zhao, J., Cheng, J., Hu, Q. *et al.* Structural evolution behavior of manganese monophosphide under high pressure: experimental and theoretical study, *J. Phys. Condens. Matter.* 29, 254002 (2017).
18. Zhao, J., Yu, Z., Hu, Q., *et al.*, Structural phase transitions of  $(\text{Bi}_{1-x}\text{Sb}_x)_2(\text{Te}_{1-y}\text{Se}_y)_3$  compounds under high pressure and the influence of the atomic radius on the compression processes of tetradymites. *Phys. Chem. Chem. Phys.* 19, 2207-2216 (2017).
19. Liu, G., Kong, L., Gong, J., Yang, W., Mao, H.-K., Hu, Q. *et al.*, T. Pressure-induced bandgap optimization in lead-based perovskites with prolonged carrier lifetime and ambient retainability. *Adv. Funct. Mater.* 27, 1604208 (2017).

## 2016

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20. Hu, Q., Kim, D.Y., Yang, W., Yang, L., Meng, Y., Zhang, L. and Mao, H.-K.  $\text{FeO}_2$  and  $\text{FeOOH}$  under deep lower-mantle conditions and Earth's oxygen-hydrogen cycles. *Nature*, 531, 241-244 (2016).
21. Zhang, Y., Wu, L., Wan, B., Lin, Y., Hu, Q., Zhao, Y., Gao, R., Li, Z., Zhang, J., Gou, H., Diverse ruthenium nitrides stabilized under pressure: a theoretical prediction. *Sci. Rep.* 6, 33506 (2016).
22. Li, C., Zhao, J., Hu, Q., Lixiu, Z., Yu, Z., and Yan, H., Crystal structure and transporting properties of  $\text{Bi}_2\text{S}_3$  under high pressure: Experimental and theoretical studies. *J. Alloys Compd.* 688, 329-335 (2016).
23. Lü, X., Wang, Y., Stoumpos, C. C., Hu, Q., *et al.*, Enhanced structural stability and photo responsiveness of  $\text{CH}_3\text{NH}_3\text{SnI}_3$  perovskite via pressure-induced amorphization and recrystallization. *Adv. Mater.* 28, 8663-8668. (2016).
24. Kong, L., Liu, G., Gong, J., Hu, Q., *et al.*, Simultaneous band-gap narrowing and carrier-lifetime prolongation of organic-inorganic trihalide perovskites. *Proc. Nat. Acad. Sci. U.S.A.* 113, 8910-8915 (2016).
25. Li, C., Ke, F., Hu, Q., Yu, Z.H., Zhao, J., Chen, Z. and Yan, H. Correlated structural and electronic phase transformation in transition metal chalcogenide under high pressure. *J. Appl. Phys.*, 119, 135901 (2016).

## 2012-2015

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26. Hu, Q., Shu, J-F., Cadien, A., Meng, Y., Yang, W., Sheng, H., and Mao, H.-K. Polymorphic phase transition mechanism of compressed coesite, *Nat. Commun.* 6, 6630 (2015).
27. Yu, Z., Wu, W., Hu, Q., Zhao, J., Li, C., Yang, K., Cheng, J., Luo, J., Wang, L. and Mao, H.-K. Anomalous anisotropic compression behavior of superconducting CrAs under high pressure. *Proc. Nat. Acad. Sci. U.S.A.* 112, 14766 (2015).
28. Wang, Y., Wu, L., Lin, Y., Hu, Q., Li, Z., Liu, H., Zhang, Y., Gou, H., Yao, Y., Zhang, J., Gao, F. and Mao, H.-K. Structures and stability of novel transition metal (M=Co, Rh, Co and Ir) borides. *Phys. Rev. B* 92, 174106 (2015).
29. Yu, Z., Lin, W., Hu, Q., Zhao, J., Yan, S., Yang, K., Suchomel, M., Sinogeikin, S., Gu, G. and Mao, H.-K. Structural phase transition in  $\text{Bi}_2\text{Se}_3$  under high pressure, *Sci. Rep.* 5, 15939 (2015).
30. Cadien, A., Hu, Q., Meng, Y., Cheng, Y., Chen, M., Shu, J., Mao, H.-K. and Sheng, H. First-order liquid-liquid phase transition in cerium, *Phys. Rev. Lett.* 10, 125503 (2013).
31. Lü, X., Hu, Q., Yang, W., Bai, L. Sheng, H., Wang, L., Huang, F., Wen, J., Miller, D. J. and Zhao, Y. Pressure-induced amorphization in single-crystal  $\text{Ta}_2\text{O}_5$  nanowires, *J. Am. Chem. Soc.* 135, 13947-13953 (2013).
32. Zeng, Q., Mao, W. L., Sheng, H., Zeng, Z., Hu, Q., Meng, Y., Lou, H., Peng, F., Yang, W., Sinogeikin, S. V.

and Jiang, J.-Z. The effect of composition on pressure-induced devitrification in metallic glasses. *Appl. Phys. Lett.* 102 171905 (2013).

33. Ding, Y., Cai, Z., Hu, Q., Sheng, H., Chang, J., Hemley, R. and Mao W. L. Nanoscale diffraction imaging of the high-pressure transition in  $\text{Fe}_{1-x}\text{O}$ , *Appl. Phys. Lett.* 100, 041903 (2012).