

## Shuhei Ono

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### Education and Training

2002 - 2007 Postdoc, Carnegie Institution of Washington, Geochemistry  
1996 - 2001 Geochemistry Ph.D., Pennsylvania State University  
1994 - 1996 M.E., Waseda University (Tokyo), Economic Geology  
1990 - 1994 B.S., Waseda University (Tokyo), Geology

### Appointments

2015 Associate Professor of Geochemistry  
Department of Earth, Atmospheric, and Planetary Sciences  
Massachusetts Institute of Technology

2011 - 2015 Kerr-McGee Career Development Assistant Professor  
Department of Earth, Atmospheric, and Planetary Sciences  
Massachusetts Institute of Technology

2007 - Assistant Professor  
Department of Earth, Atmospheric, and Planetary Sciences  
Massachusetts Institute of Technology

2005 - 2007 Agouron Geobiology Fellow  
2002 - 2005 Carnegie Postdoctoral Fellow  
Carnegie Institution of Washington

### Honors

2011 Kerr-McGee Career Development Professor, MIT  
2011 Top-50 most cited articles, *Geochimica Cosmochimica Acta*, Elsevier  
2009 Ferry Award, School of Science, MIT  
2006 Jubilee Medal, Geological Society of South Africa  
2005 - 2007 Agouron Geobiology Fellowship

### Publications in peer reviewed journals (\* denote student/postdoc)

48. Syverson D.D., Ono S., Shanks W.C., Seyfried W.E. (2015) Multiple Sulfur Isotope Fractionation and Mass Transfer Processes during Pyrite Precipitation and Recrystallization: An Experimental Study at 300 and 350°C. *submitted to Geochimica Cosmochimica Acta*, **165**, 418-434
47. Stefánsson A., Keller N.S., Gunnarsson R., Ono S., (2015) Multiple sulfur isotope systematics of Icelandic Geothermal fluids and the source and reactions of

- sulfur in volcanic geothermal systems on divergent plate boundaries.  
*submitted to Geochimica Cosmochimica Acta*, **165**, 307-323
46. Park B., Womack C., Whitehill\* A., Jiang J., Ono S., and Field R. (2015), Millimeter-wave optical double resonance schemes for rapid assignment of perturbed spectra, with applications to the  $\tilde{C}1B2$  state of  $SO_2$ , *submitted to Journal of Chemical Physics*, **142**, 144201
45. Sim M-S, Ono S., Hurtgen M., (2015) Sulfur isotope evidence for low and fluctuating sulfate levels in the late Devonian ocean and the potential link with the mass extinction event. *Earth and Planetary Science Letters*, **419**, 52-62
44. Wang\* D.T., Gruen\* D.S., Sherwood Lollar, B. Hinrichs K-U, Stewart L.C., Holden J.F., Hristov A.N., Pohlman J.W., Morrill P.L., Könneke M., Delwiche, K.B., Reeves\* E.P., Sutcliffe C.N., Ritter D.J., Seewald J.S., McIntosh J.C., Hemond H.F., Kubo M.D., Cardace D., Hoehler T.M., and Ono S., (2015) Nonequilibrium clumped isotope signals in microbial methane. *Science* **348**, 428-431, doi: 10.1126/science.aaa4326
43. McDermott J.M., Ono S., Tivey M.K., Seewald J.S., Shanks W.C., Solow A.R., (2015) Identification of sulfur sources and isotopic equilibria in submarine hot-springs using multiple sulfur isotopes. *Geochimica Cosmochimica Acta* **160**, 169-187
42. Luo G.\*, Ono S., Huang J., Algeo J.T., Li C., Zhou L., Robinson A., Lyons T.W., Xie S. (2015) Decline in oceanic sulfate levels during the early Mesoproterozoic. *Precambrian Research*, **258**, 36-47
41. Whitehill\* A.R., Jiang A., Guo H., Ono S. (2015)  $SO_2$  photolysis as a source for sulfur mass-independent isotope signatures in stratospheric aerosols. *Atmospheric Chemistry and Physics*, **15**, 1843-1864
40. Ono S., Sim M.S.\*, Bosak T. (2014a) Commentary: Predictive model connects microbes in culture and nature. *Proceedings of National Academy of Science*. 10.1073/pnas.1420670111
39. Leavitt, W. D., Cummins R., Schmidt M. L., Sim\* M. S., Ono S., Bradley A. S. and Johnston D. T. (2014) Multiple sulfur isotope signatures of sulfite and thiosulfate reduction by the model dissimilatory sulfate-reducer, *Desulfovibrio alaskensis* str. G20. *Frontiers in Microbiology* **5**. Article 591, doi: 10.3389/fmicb.2014.00591
38. Ono S., Wang\* D. T., Gruen\* D. S., Sherwood Lollar, B., Zahniser, M. S., McManus, B. J., and Nelson, D. D. (2014b) Measurement of a doubly substituted methane isotopologue,  $^{13}CH_3D$ , by tunable infrared laser direct absorption spectroscopy. *Analytical Chemistry* **86**, 6487-6494.
37. Joelsson L.M.T., Forecast R., Schmidt J.A., Meusinger C., Nilsson E.J.K., Ono S., Johnson M., (2014) Relative rate study of kinetic isotope effect of  $^{13}CH_3D$  + Cl. *Chemical Physics Letters* **605-606**, 152-157
36. Meredith, L. K., Rao, D., Bosak, T., Klepac-Ceraj, V., Tada, K. R., Hansel, C. M., Ono S., and Prinn, R. G., (2014) Consumption of atmospheric hydrogen during the life cycle of soil-dwelling actinobacteria. *Environmental Microbiology Reports* **6**, 226-238.

35. Guy B., Ono S., Gutzler J., Beukes N.J., (2014) Sulfur sources of sedimentary 'Buckshot' pyrite in the auriferous conglomerates of the Mesoarchean Witwatersrand and Ventersdorp Supergroups, Kaapvaal Craton, South Africa, *Mineralium Deposita* **49**, 751-775
34. Harris\* E., Nelson D.D., Olsewski\* W., Zahniser M., McManus B.J., Whitehill\* A., Potter\*, K., Prinn R., and Ono S. (2014) Development of a spectroscopic technique for continuous online monitoring of oxygen and site-specific nitrogen isotopic composition of atmospheric nitrous oxide. *Analytical Chemistry* **86**, 1726-34
33. Harris\* E., Sinha, B., Hoppe, P., & Ono, S. (2013). High-precision measurements of <sup>33</sup>S and <sup>34</sup>S fractionation during SO<sub>2</sub> oxidation reveal causes of seasonality in SO<sub>2</sub> and sulfate isotopic composition. *Environmental Science & Technology*, **47**, 12174–83. doi:10.1021/es402824c
32. Whitehill\* A.R., X. Xie, X. Hu, D. Xie, H. Guo, S. Ono (2013) Vibronic origin of mass-independent isotope effect in photoexcitation of SO<sub>2</sub> and the implications to the early Earth's atmosphere. *Proceeding of National Academy of Science* **110**, 17697-702
31. Johnson, J.E., Webb S.M., Thomas\* K., Ono S., Kirschvink J.L., Fischer W.W. (2013) Manganese-oxidizing photosynthesis before the rise of cyanobacteria. *Proceeding of National Academy of Science* **110**, 11238-11243
30. Sim\* M.S., D. Wang, Z. Grant, J. Wall, T. Bosak, S. Ono (2013) Fractionation of sulfur isotopes by *Desulfovibrio vulgaris* mutants lacking hydrogenases or type I tetraheme cytochrome *c*<sub>3</sub>. *Frontiers in Microbiology*. doi:10.3389/fmicb.2013.00171
29. Potter\*, K., Ono S., Prinn R. (2013) Fully-automated, high-precision instrumentation for the isotopic analysis of tropospheric N<sub>2</sub>O using continuous flow isotope ratio mass spectrometry. *Rapid Communications in Mass Spectrometry* **27**, 1723-1738
28. Ono, S., Whitehill\* A, and Lyons J. (2013) Contribution of isotopologue self-shielding to sulfur mass-independent fractionation during sulfur dioxide photolysis. *Journal of Geophysical Research-Atmosphere*. **118**(5), 2444-2454
27. Lever M. A., Rouxel O., Alt J. C., Shimizu N., Ono S., Coggon R. M., Shanks W. C., et al. (2013). Evidence for Microbial Carbon and Sulfur Cycling in Deeply Buried Ridge Flank Basalt. *Science* **339**(6125), 1305–1308
26. Sim\* M.S., Ono S., Bosak T., (2012) Effects of iron and nitrogen limitation on sulfur isotope fractionation during microbial sulfate reduction. *Applied and Environmental Microbiology*. **78**(23), 8368-8376
25. Whitehill\* A., Ono S. (2012) Excitation band dependence of sulfur isotope mass-independent fractionation during photolysis of sulfur dioxide using broadband light sources. *Geochimica Cosmochimica Acta* **94**, 238-253
24. Guy B. M., Ono S., Gutzmer J., Kaufman A. J., Lin Y\*, Fogel M. L., & Beukes N. J. (2012) A multiple sulfur and organic carbon isotope record from non-conglomeratic sedimentary rocks of the Mesoarchean Witwatersrand Supergroup, South Africa, *Precambrian Research* **219**, 208–231.

23. Ono, S., Keller\* N., Rouxel O., Alt J., (2012) Sulfur-33 constraints on the origin of secondary pyrite in altered ocean basement, *Geochemica Cosmochimica Acta* **87**, 323-340
22. Kopf\* S. and Ono S. (2012) Sulfur mass-independent fractionation in liquid phase chemistry: UV photolysis of phenacylphenylsulfone as a case study. *Geochimica Cosmochim Acta* **85**, 160-169
21. Harris E., B. Sinha, P. Hoppe, Crowley J., Ono S., Foley S. (2012) Sulfur isotope fractionation during oxidation of sulfur dioxide: Gas-phase oxidation by OH radicals and aqueous oxidation by H<sub>2</sub>O<sub>2</sub>, O<sub>3</sub> and iron catalysis. *Atmospheric Chemistry and Physics* **12**, 407-423
20. Lin\* Y., Sim\* M.S., and Ono S. (2011) Multiple-sulfur isotope effects during photolysis of carbonyl sulfide. *Atmospheric Chemistry and Physics* **11**, 10283-10292
19. Sim\* M.S., Bosak T., and Ono S. (2011) Large sulfur isotope fractionation does not require disproportionation, *Science* **333**, 74-77
18. Sim\* M.S., Ono S., Donovan K., Templer S.P., and Bosak T. (2011) Effect of electron donors on the fractionation of sulfur isotopes by a marine desulfobivrio sp., *Geochimica Cosmochim Acta* **75**, 4244-4259
17. Ono S., and Fayek M. (2011) Decoupling of O and Pb isotope systems of uraninite in the early Proterozoic Conglomerates in the Elliot Lake district, *Chemical Geology* **288**, 1-13
16. Bosak, T., Bush, J., Flynn, M., Liang, B., Ono S., Petroff A. P., and Sim\* M.S. (2010), Formation and stability of oxygen-rich bubbles that shape photosynthetic mats, *Geobiology* **8**, 1-11
15. Ono S., Beukes N.J., and Rumble D. (2009) Origin of two distinct multiple-sulfur isotope compositions of pyrite in the 2.5 Ga Klein Naute Formation, Griqualand West Basin, South Africa. *Precambrian Research* **169**, 48-57
14. Ono S., Kaufman A.J., Farquhar J., Sumner D., and Beukes N.J. (2009) Lithofacies control on multiple-sulfur isotope records and the Neoproterozoic sulfur cycles. *Precambrian Research* **169**, 58-67
13. Ueno Y, Ono S., D. Rumble, and S. Maruyama (2008) Quadruple sulfur isotope analysis of ca. 3.5 Ga Dresser Formation: new evidence for microbial sulfate reduction in the Early Archean. *Geochimica Cosmochimica Acta* **72**, 5675-5691
12. Ono S., (2008) Multiple-sulphur isotope biosignatures. Strategies for life detection. *Space Science Reviews* **135**, 203-220
11. Rouxel O., Ono S., Alt J., Rumble D., Ludden J. (2008) Sulfur Isotope Evidence for Microbial sulfate reduction in altered oceanic basalts at ODP site 801. *Earth and Planetary Science Letters* **268**, 110-123
10. Ono S., Shanks W.C., Rouxel O., Rumble D. (2007) S-33 constraints on the seawater sulfate contribution in modern seafloor hydrothermal vent sulfides. *Geochimica et Cosmochimica Acta* **71**, 1170-1182
9. Kasting J. F. and Ono S. (2006) Palaeoclimates: the first two billion years. *Philosophical Transactions Royal Society London Biological Sciences*, **361**, 917-929.

8. Ono S., Wing B., Johnston D., Rumble D., Farquhar J. (2006) Mass-dependent fractionation of quadruple stable sulfur isotope system as a new tracer of sulfur biogeochemical cycles. *Geochimica et Cosmochimica Acta* **70**, 2238-2252
7. Ono S., Wing B., Farquhar J., and Rumble D. (2006) High precision analysis of all four stable isotopes of sulfur ( $^{32}\text{S}$ ,  $^{33}\text{S}$ ,  $^{34}\text{S}$  and  $^{36}\text{S}$ ) at nanomole levels using a laser fluorination isotope-ratio-monitoring gas chromatography-mass spectrometry. *Chemical Geology* **225**, 30-39
6. Ono S., Beukes N.J., Rumble D., Fogel M. (2006) Early evolution of Earth's atmospheric oxygen from multiple-sulfur and carbon isotope records of the 2.9 Ga Pongola Supergroup, Southern Africa. *South African Journal of Geology* **109**, 97-108
5. Fehr M.A., Rehkämper M., Halliday A.N., Wiechert U., Hattendorf B., Günther D., Ono S., Eigenbrode J. L., Rumble D. (2005) Tellurium isotopic composition of the early solar system - A search for effects resulting from stellar nucleosynthesis,  $^{126}\text{Sn}$  decay, and mass-independent fractionation. *Geochimica Cosmochimica Acta*, **69**, 5099-5112.
4. Ono S., Eigenbrode J.L., Pavlov A.A., Kharecha P., Rumble D., Kasting J.F., and Freeman K. H. (2003) New insights into Archean sulfur cycle from mass-independent sulfur isotope records from the Hamersley Basin, Western Australia. *Earth and Planetary Science Letter* **213**, 15-30
3. Ono S., Ennyu A., Najjar R. G., and Bates N. (2001) Shallow remineralization in the Sargasso Sea estimated from seasonal variations in oxygen dissolved inorganic carbon, and nitrate. *Deep Sea Research II* **48**, 1567-1582
2. Ohmoto H., Yamaguchi K.E., and Ono S. (2001) Questions regarding Precambrian sulfur isotope fractionation. *Science*, **292**, 1959a.
1. Mariko T., Kawada M., Miura M., and Ono S. (1996) Ore formation processes of the Mozumi skarn-type Pb-Zn-Ag deposits in the Kamioka Mine, Gifu Prefecture, central Japan; a mineral chemistry and fluid inclusion study. *Resource Geology* **6** (260) 337-354

#### **Invited Conference Talks Since 2010**

- 2015 Goldschmidt Conference (Keynote), Prague, Czech Republic
- 2015 Deep Carbon Observatory, Munich, Germany
- 2014 4th international workshop on clumped isotopes, ETH, Zurich (plenary talk)
- 2014 Goldschmidt conference, Sacramento, California (keynote)
- 2014 Deep Carbon Observatory, Lyon, France (invited talk)
- 2014 Deep Carbon Observatory, Rice University (plenary talk)
- 2013 Deep Carbon Observatory, International Science Meeting (plenary talk)
- 2011 Workshop for sulfur mass-independent fractionation, Alexandria (invited)
- 2011 Conference on Atmospheric and Molecular Science, Copenhagen (invited)
- 2010 BES Earth Sciences Council Workshop, The Chemistry of Novel Isotope Effects in the Geosciences, San Francisco, CA (invited talk)
- 2010 AGU Fall Meeting (invited talk)

#### **Invited Seminar**

2015 Yale University, Energy Science Institute  
2015 Tokyo Institute of Technology, Earth Life Science Institute  
2014 Marquette University  
2014 Michigan State University  
2013 Carnegie Institute of Washington  
2013 Arizona State University  
2013 University of Toronto  
2013 University of Massachusetts, Amherst  
2013 University of Chicago  
2012 University Rhode Island  
2012 University of Minnesota  
2011 California Institute of Technology  
2011 Boston University  
2011 Rutgers University  
2010 University of Toronto  
2009 Yale University  
2008 Rice University

### **Synergistic Activities**

2016, co-organizer, Telluride conference for mass-independent fractionation  
2014-16, International Organization Liaison Committee, Goldschmidt Conference  
    2016, Yokohama, Japan, Geochemical Society  
2013-15, Clark award committee, Geochemical Society  
2013-14, Editor, Geochemical News, Geochemical Society  
2013 Session Chair, Goldschmidt conference, Florence, Italy  
2012 Co-Organizer, International Symposium on Isotopomers, Washington DC  
2010 Session Chair, Goldschmidt conference, Knoxville, TN  
2010 Scientific Committee, International Symposium on Isotopomers, Amsterdam,  
    Netherlands  
2008 International Program Committee, Goldschmidt Conference, Vancouver,  
    Canada

Reviewer for research articles for *Geochimica et Cosmochimica Acta*, *Science*,  
    *Geobiology*, *Earth and Planetary Science Letters*, *Nature*, and others, and  
    research proposals for NSF, NASA, IODP, and served for review panels for  
    NASA-ROSES and NSF-EAR.

### **Students supervised**

#### **MS**

2011 Thomas, Katherine, "Stable Isotope and Organic Biomarker Analysis of the  
    Late Proterozoic Coppercap Formation in the MacKenzie Mountains  
2010 Sebastian, Kopf, "Exploring the Contributions of Aqueous-phase Sulfur  
    Chemistry to the Mass-Independent Sulfur Fractionation of the Archean Rock  
    Record.

#### **PhD**

- 2018 (in progress) Danielle S. Gruen, “Clumped methane isotope geochemistry of microbial methanogenesis and methanotrophy”
- 2016 (in progress) David T. Wang, “Clumped methane isotope investigation of natural methane.”
- 2014 Andrew R Whitehill, “Mass-independent sulfur isotope fractionation during photochemistry of sulfur dioxide.”
- 2012 Min Sub Sim, “Sulfur isotope effect by sulfate reducing bacteria” co-advised with Tanja Bosak, currently Agouron Geobiology Fellow at Caltech
- 2011 Katherine Potter, Nitrous oxide (N<sub>2</sub>O) isotopic composition in the troposphere: instrumentation, observations at Mace Head, Ireland, and regional modeling” main supervisor was Ronald Prinn

### **Postdoctoral Researchers Supervised and Their Current Positions**

- 2014 - Genming Luo, MIT
- 2014 - 2015 Shikma Zaarur, MIT
- 2013 - 2015 Eoghan Reeves, MIT
- 2012 - 2013 Eliza Harris, currently at EMPA, ETH
- 2011 - 2013 Harry Oduro, currently a lecturer (assistant professor) at University of St. Andrews
- 2008 - 2010 Nicole Keller, currently a research scientist at Institute of Earth Sciences, University of Iceland
- 2008 - 2009 Ying Lin, Sanya Institute of Deep-Sea Science and Engineering, China

### **Undergraduate Students Supervised**

- 2011-2013 Eileen Molzberger, U of Wisconsin
- 2013 Xinnan Wang, University of Science and Technology of China
- 2012 Anna Merrifield, MIT
- 2010 Christopher Hoff, Acton High School (High School Intern)
- 2009-2011 Katie Donovan, Wellesley College
- 2009 Evelyn Cordner, MIT

### **Teaching**

- 12.104, Geochemistry of the Earth and Planet
- 12.335, Experimental Atmospheric Chemistry
- 12.490, Current Topics in Stable Isotope Geochemistry
- 12.490, Stable Isotope Geochemistry and Biogeochemical Cycles
- 12.490, Current Topics in Astrobiology and Geobiology
- 12.491, Biogeochemistry of Sulfur

### **Internal Service**

- 2009-present Joint Committee on Chemical Oceanography, MIT-WHOI Joint Program
- 2011-15 EAPS Graduate Admission Committee
- 2011 MISTI Global Seed Funds Scientific Committee
- 2011 Commencement

2010 EAPS Graduate Committee  
 2009 Organizer, EAPS IAP Seminar Series  
 2008 Organizer, EAPS IAP Seminar Series

### **Thesis Committee**

MIT-EAPS: Katherine Potter, Diane Ivy, Laura Meredith, Jimmy Gasore, Michael McClellan  
 WHOI-MIT Joint Program: Carly Buchwald, Jill McDermott, Guy Nathaniel Evans  
 MIT-Civil and Environmental Engineering: Alison Hoyt

### **Thesis Defense Chair**

EAPS: David Fike  
 WHOI-MIT Joint Program: Jacob Waldbauer, Caitlin Frame

### **External thesis committee**

University of Johannesburg: Bradley Guy  
 University of Maryland: Yadviga Zhelezinskaya

### **Current Funding**

- 2015 NASA Astrobiology Institute/University of Colorado Boulder, Rock powered life. \$ 340k to Ono.
- 2014 Shell/MIT Energy Initiative, Doubly-isotope substituted methane,  $^{13}\text{CH}_3\text{D}$ , as a new tool of methane source characterization. \$ 150k
- 2014 NASA Exobiology: Photochemistry and spectroscopy of sulfur dioxide, sulfur monoxide, and elemental sulfur as source reactions for Archean sulfur mass-independent fractionation. \$ 392k
- 2014 DOE-Aerodyne Research: Dual Quantum Cascade Laser System for Simultaneous Measurements of  $^{13}\text{CH}_4$  and  $\text{CH}_3\text{D}$  Methane Isotopologues. \$ 275k to Ono
- 2013 NSF-FESD Type I: The dynamics of Earth system oxygenation. \$ 200k to Ono
- 2013 NSF EAR-Low Temperature Geochemistry: Application of Quantum Cascade Laser-Infrared Absorption Spectroscopy for Methane Clumped Isotope Thermometry Using Doubly Isotope Substituted Methane ( $^{13}\text{CH}_3\text{D}$ ). \$ 140k
- 2013 Alfred P. Sloan Foundation – Ohio State University: Reduced carbon in Earth: Origin and distribution of abiotic hydrocarbons. \$ 73k
- 2013 ENI/MIT Energy Initiative: *Ab initio* Computations and Lab Measurements on Liquids-to-Gas Cracking for Improved Modeling of Hydrocarbons in Geological Formations. ca. 507k to Ono
- 2012 DOE - Aerodyne Research: Quantum Cascade Laser System for Simultaneous Measurements of  $^{13}\text{CO}$  and  $\text{C}^{18}\text{O}$  carbon monoxide Isotopologues. \$ 99k

### **Collaborators**

Ronald G. Prinn, Tanja Bosak, Roger E. Summons, EAPS, MIT  
 Robert W. Field, Department of Chemistry, MIT  
 William H. Green, Department of Chemical Engineering, MIT



Harold F. Hemond, Charles F. Harvey, Department of Civil and Environmental Engineering, MIT  
David D. Nelson, Mark Zahniser, Barry J. McManus, Aerodyne Research Inc.  
William Seyfried Jr., Department of Earth Sciences, University of Minnesota  
Hua Guo, Department of Chemistry, University of New Mexico  
Nicolas J. Beukes, Department of Geology, University of Johannesburg  
James F. Holden, Department of Microbiology, University of Massachusetts  
Barbara Sherwood Lollar, Department of Earth Sciences, University of Toronto  
Kai-Uwe Hinrichs, MARUM center for Marine Environmental Sciences, U. of Bremen

**Graduate and Postdoctoral Advisors**

Hiroshi Ohmoto (Ph. D. Supervisor) Department of Geosciences, the Pennsylvania State University  
Douglas Rumble III, (Postdoctoral advisor) Geophysical Laboratory, Carnegie Institution of Washington