

Curriculum vitae

Dr. Elizabeth D. Swanner

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EDUCATION

University of Colorado, Boulder; PhD from the Department of Geological Sciences, CU-Boulder; July 2011. Specialty: Geomicrobiology; Advisor: Prof. Dr. Alexis S. Templeton.

Teaching Certificate, Graduate Teacher Program, CU-Boulder. 2012.

Astrobiology Certificate, Center for Astrobiology, CU-Boulder. 2011.

Mount Holyoke College, South Hadley, MA; Bachelor of Arts with High Honors in Biochemistry; May 2003. Major: Biochemistry; Minor: English

EMPLOYMENT

Associate Professor, Department of Geological & Atmospheric Sciences, Iowa State University, Ames, IA. Aug. 2020-present.

Assistant Professor, Department of Geological & Atmospheric Sciences, Iowa State University, Ames, IA. Aug. 2015-present.

Carl Zeiss Stiftung Postdoctoral Fellow, Department of Geoscience, University of Tübingen, Germany. 2014-2015. Advisors: Ronny Schoenberg & Andreas Kappler.

Postdoctoral Researcher, Department of Geoscience, University of Tübingen, Germany. 2013-2014. Advisors: Ronny Schoenberg & Andreas Kappler.

NSF Postdoctoral Fellow, Department of Geoscience, University of Tübingen, Germany. 2011-2013. Advisors: Andreas Kappler & Martin Obst.

GRANTS

Funded at ISU

30. Advanced Photon Source, General User Proposal, "Tracking aquatic redox conditions and biogeochemistry through Fe, Mn and S mineral (trans)formations." PI: E Swanner. 2020 (access to facility).

29. National Science Foundation, "CAREER: Quantifying the extent and biogeochemical impact of modern ferruginous lakes." PI: E. Swanner. 2020-20205 (\$662,511).

28. Center for Health Effects of Environmental Contamination (CHEEC), "Degradation of 2,4-D by Fe(II)-oxidizing bacteria in Iowa's surface and groundwater." PI: E. Swanner. 2020-2021 (\$21,830).
27. Leopold Center for Sustainable Agriculture, "Degradation of herbicides by Fe(II)-oxidizing bacteria in Iowa's surface and groundwater." PI: E Swanner. 2019 (\$1002).
26. Advanced Photon Source, General User Proposal, "Down-core mapping of sedimentary diagenesis within anoxic lake sediments." PI: E Swanner. 2019 (access to facility).
25. Hach, Request for DR 1900 spectrophotometer. PI: E Swanner. 2019 (in-kind donation; list price \$5,324).
24. Leopold Center for Sustainable Agriculture, "The history of biological activity and climate records in Loess Hills pedogenic carbonates." PI: E Swanner. 2019 (\$2,227).
23. National Aeronautics and Space Administration (NASA) ROSES Exobiology, "Refining the geochemical toolkit for paleoredox reconstruction: uranium isotope behavior under suboxic, anoxic, and iron-rich conditions." PI: Stephen Romaniello, Co-PI: G Gilleaudeau, Co-I: Elizabeth Swanner. 2019-2021 (\$57,320 to ISU).
22. Petroleum Research Fund, Doctoral New Investigator (American Chemical Society), "Determining the mechanism(s) of sedimentary pyrite formation from anoxic (pore)waters." PI: Elizabeth Swanner. 2019-2020 (\$110,000).
21. Iowa Space Grant, Early Career Investigator Research Program (ECIRP), "Earth analogues for sedimentary manganese enrichments observed in a Martian paleolake." PI: Elizabeth Swanner. October 2018-June 2019 (\$7500).
20. Huron Mountain Wildlife Foundation, "Microbial pathways of iron and methane cycling in ferruginous Canyon Lake." PI: E Swanner, Co-PI: C Wittkop, S Katsev, and C Sheik. 2018 (\$0 for continuing access as part of NSF-sponsored project).
19. Hach, Request for DR 1900 spectrophotometer. PI: E Swanner. 2017 (in-kind donation; list price \$3,369).
18. Environmental Protection Agency, EPA-G2017-STAR-A1, Freshwater Harmful Algal Blooms: "A systems approach for understanding, predicting, and managing harmful algal blooms in Midwestern lakes." PI: A Howe, Co-PI: K Ikuma, E Swanner, & J. Choi. 2018-2020 (\$760,000 to ISU).
17. Huron Mountain Wildlife Foundation, "Microbial pathways of iron and methane cycling in ferruginous Canyon Lake." PI: E Swanner, C Wittkop, S Katsev, and C Sheik. 2017 (\$1000 to Swanner).
16. National Science Foundation (NSF), EAR - 1660691, EAR - 1660761, EAR - 1660873, "Collaborative Research: Biosignatures of coupled iron and carbon cycling in ferruginous lakes." PI: E Swanner, Co-PI: C Wittkop & S Katsev. 2017-2020 (\$227,893 to Swanner; \$416,005 total).
15. Iowa Water Center, "The role of iron mobility from anoxic sediments in stimulating harmful algal blooms." PI: E Swanner. 2017-2018 (\$30,000).
14. Foreign Travel Grant, ISU, Goldschmidt Geochemistry Conference, Yokohama, Japan. Oct. 2016 (\$1186.50).
13. Huron Mountain Wildlife Foundation, "Constraining pathways of methane, nutrient, and iron cycling in ferruginous Canyon Lake." PI: C Wittkop, S Katsev, and E Swanner. 2016 (\$3,450 total, \$1,773 to Swanner).

12. Iowa Water Center, “The role of iron mobility from anoxic sediments in stimulating harmful algal blooms.” PI: E Swanner. 2016-2017 (\$29,733).

Funded prior to ISU

11. European Synchrotron Radiation Facility (ESRF), Beamtime granted for “Development of a carbonate proxy for the Fe(II) concentration and Fe isotope composition of ancient seawater.” S Eroglu and ED Swanner. 2015 (access to facility with funded travel and accommodation).

10. NachwuchswissenschaftlerInnen, grant for young researchers from the University of Tübingen, “Development of a carbonate proxy for the Fe concentration, Fe isotope composition, and oxygen concentration of ancient seawater.” PI: E Swanner. 2014-2015 (€35,000).

9. Carl Zeiss Stiftung, Postdoctoral Fellowship, “Rusty fingerprints of early cyanobacteria: the fate of Fe(II) during oxygenic photosynthesis.” PI: E Swanner. August 2014-July 2016 (€200,000).

8. Deutsche Forschungsgemeinschaft Schwerpunktprogram, “Building a Habitable Earth”. Helped to write the Geobiology section, program funded March 2014.

7. Stanford Synchrotron Radiation Lightsource (SSRL), Active beamtime proposal for “Fate of Co during diagenetic pyrite formation.” ED Swanner, M Obst and A Kappler. 2013-2016 (access to facility).

6. Deutsche Forschungsgemeinschaft Project Grant, “Microbial and diagenetic origins for BIFs mineralogy.” A Kappler, M Obst and E Swanner* (*primary author). 2011-2014 (€178,900).

5. National Science Foundation (NSF) International Research Fellowship Program, “Constraining the role of photosynthetic organisms in deposition of Banded Iron Formations (BIF) on early Earth.” PI: E. Swanner. 2011-2013 (\$152,475).

4. National Aeronautics and Space Administration (NASA) Astrobiology Institute, grant to host the Astrobiology Graduate Conference (AbGradCon). 2011 (\$35,000).

3. National Science Foundation (NSF) East Asia and Pacific Summer Institutes, Geomicrobiology at Japan Agency for Marine Earth Science and Technology. PI: E Swanner. 2007 (ca. \$10,000).

2. Mentorship Grant, Department of Geological Sciences, CU-Boulder. 2010 (\$1000).

1. Geological Society of America (GSA), Graduate Student Research Grant. 2010 (\$2352).

AWARDS

11. Iowa State University, College of Liberal Arts & Sciences (LAS) Early Achievement in Research Award, 2020.

10. Geological Society of America (GSA) Geobiology and Geomicrobiology (GBGM) Division Pre-tenure Award, 2019.

9. Best Student Talk, Hydrogeology Symposium, CU-Boulder. 2011 (\$100).

8. Nordic-NASA Astrobiology, summer school on “Water, Ice and the Origin of Life in the Universe” in Iceland, accepted in 2009 (declined).

7. NASA Astrobiology Institute, International Summer School of Astrobiology, Santander, Spain, accepted in 2009.

6. Colorado Scientific Society, Invited talk on student night; 3rd Prize. 2009 (\$75).
5. "Best Should Teach" Silver Award, CU-Boulder. 2008 & 2009.
4. Mary Lyon Scholar, Mount Holyoke College. 2003.
3. Louisa Stone Stevenson Prize, Mount Holyoke College. 2002.
2. National Scholar-Athlete, Collegiate Rowing Coaches Association. 2001 & 2002.
1. NEWMAC Academic All-Conference. 2001.

SCHOLARSHIP

Publications

Google Scholar h-index: 16; 1080 citations (October 2020)

*Denotes student or postdoc author supervised by Swanner

Submitted

36. Erickson ML, Swanner ED, Ziegler BA, and JR Havig. "Months-long spike in aqueous As following domestic well installation and disinfection: short- and long-term drinking water quality implications." In revision for *Journal of Hazardous Materials*.

35. *Leung T, Wilkinson G, and ED Swanner. "The role of iron availability during cyanobacteria dominance of algal blooms, as monitored by chlorophyll fluorescence." In revision for *Inland Waters*

34. Swanner ED, *Lambrecht N, Wittkop C, Harding C, Katsev S, Torgeson J, and SW Poulton. "The biogeochemistry of ferruginous lakes and past ferruginous oceans." Resubmitted to *Earth-Science Reviews*.

33. Tong H, Li B, Swanner E, Liu C, Chen MJ, Xia Y, Liu Y, Ning Z, Li F, and X Feng. "Microaerophilic oxidation of Fe(II) coupled with simultaneous carbon fixation and As(III) oxidation and sequestration in karstic paddy soil." Resubmitted to *Environmental Science & Technology*.

In press

32. Kappler A, Bryce C, Mansor M, Byrne JM, Swanner ED, and U Lueder. "An evolving view on biogeochemical cycling of iron." In revision for *Nature Reviews Microbiology*.

2020

31. Cole DB, Planavsky NJ, Longley M, Böning P, Wilkes D, Wang X, Swanner ED, Wittkop C, Busigny V, Knudsen A, and EA Sperling. "Uranium isotope fractionation in anoxic settings and the global uranium isotope mass balance." (2020) *Global Biogeochemical Cycles*, 34(8).

30. Lee J, Choi J, *Fatka M, Swanner ED, Ikuma K, Liang X, *Leung T, and A Howe. "Improved detection of *mcyA* genes and their phylogenetic origins in harmful algal blooms." (2020) *Water Research*, 176(115730).

29. Wittkop C, Swanner ED, *Lambrecht N, Myrbo A, Grengs A, Torgeson J, and S Katsev. "Manganese carbonates signal suboxic methanotrophy in ferruginous environments." *Earth & Planetary Science Letters*.

28. *Lambrecht NL, Wittkop C, Katsev S, Sheik C, Fakhraee M, Hall SJ, and ED Swanner. "Biogeochemical and physical controls on methane fluxes from two meromictic ferruginous lakes." (2020) *Geobiology*, 18(1):54-69.

2019

27. *Tong H, Hao L, Chen MJ, Li F, Liu C, Swanner E, Xia Y, Liu Y, and Y Liu. "Biological Fe(II) and Arsenic Oxidation for Arsenic Immobilization in Microaerophilic Environments." (2019) *Geochimica et Cosmochimica Acta*, 265: 96-108.

26. Swanner ED, Webb SM, and A Kappler. "Fate of cobalt and nickel in mackinawite during diagenetic pyrite formation." (2019) *American Mineralogist*, 104: 917-928.

25. Babechuk M, Weimar N, Kleinhanns I, *Eroglu S, Swanner ED, Kenny G, Kamber B, and R Schoenberg. "Pervasively anoxic surface conditions at the onset of the Great Oxidation Event: new multi-proxy constraints from the Cooper Lake paleosol." (2019) *Precambrian Research*, 323: 126-163.

2018

24. *Lambrecht N, Wittkop C, Katsev S, Fakhraee M, and ED Swanner. "Geochemical characterization of two ferruginous meromictic lakes in the Upper Midwest, U.S.A." (2018) *JGR Biogeosciences*, 123(10): 3403-3422.

23. *Eroglu S, Schoenberg R, Pascarelli S, Beukes N, Kleinhanns I, and E Swanner. "Iron speciation and isotope systematics of the Neoproterozoic Campbellrand-Malmani carbonate platform, South Africa." (2018) *American Journal of Science*, 318(4):367-408.

22. Swanner ED, *Wu W, *Maisch M, and A Kappler. "Oxic Fe(III) reduction could have generated Fe(II) in the photic zone of Precambrian seawater." (2018) *Scientific Reports*, 8(1):4238.

21. Konhauser KO, Robbins LJ, Alessi DS, Flynn SL, Gingras MK, Martinez RE, Kappler A, Swanner ED, Li Y-L, Crowe SA, and SV Lalonde. "Phytoplankton contributions to the trace element composition of Precambrian banded iron formation." (2018) *GSA Bulletin*.

2017

20. Eroglu S, van Zuilen M, Taubald H, Drost K, Wille M, Swanner E, Beukes N, and R Schoenberg. "Continuously increasing oxidation state by organic burial on shallow marine shelves during the Neoproterozoic." (2017) *Precambrian Research*, 302:122-139.

19. *Wu W, Swanner ED, Kleinhanns IC, Schoenberg R, Pan Y, and A Kappler. "Fe isotope fractionation during Fe(II) oxidation by the marine photoferrotroph *Rhodovulum iodosum* in the presence of Si – Implications for Precambrian iron formation deposition." (2017) *Geochimica et Cosmochimica Acta*, 211: 307-321.

18. Swanner ED, *Bayer T, *Wu W, Hao L, Obst M, Sundman A, Byrne JM, Michel FM, Kappler A, and R Schoenberg. "Iron isotope fractionation during Fe(II) oxidation mediated by the oxygen-producing

marine cyanobacterium *Synechococcus* PCC 7002." (2017) *Environmental Science & Technology*, 51(9): 4897-4906.

2016

17. *Maisch, M, Wu, W, Kappler, A and ED Swanner. "Laboratory simulation of an iron(II)-rich Precambrian marine upwelling system to explore the growth of photosynthetic bacteria." (2016) *Journal of Visualized Experiments*, 113:e54251.

16. *Halama M, Swanner ED, Konhauser KO, and A Kappler. "Evaluation of siderite and magnetite formation in BIFs by pressure-temperature experiments of Fe(III) minerals and microbial biomass." (2016) *Earth and Planetary Science Letters*, 450:243-253.

15. Hao L, Guo Y, Byrne JM, Zeitvogel F, Schmid G, Ingino P, Li J, Neu TR, Swanner ED, Kappler A, and M Obst. "Binding of heavy metal ions in aggregates of microbial cells, EPS and biogenic iron minerals measured in-situ using metal- and glycoconjugates-specific fluorophores." (2016) *Geochimica et Cosmochimica Acta*, 180:66-96.

2015

14. Swanner ED, Wu W, Hao L, *Wuestner ML, Obst M, Moran DM, McIlvin M, Saito M and A Kappler. "Physiology, Fe(II) oxidation, and Fe mineral formation by a marine planktonic cyanobacterium grown under ferruginous conditions." (2015) *Frontiers in Earth Science*, 3.

2015 and earlier (prior to ISU start)

13. Swanner ED, *Wu W, Schoenberg R, Byrne J, Michel FM, Pan Y and A Kappler. "Fractionation of Fe isotopes during Fe(II) oxidation by a marine photoferrotroph is controlled by the formation of organic Fe-complexes and colloidal Fe fractions." (2015) *Geochimica et Cosmochimica Acta*, 165:44-61.

12. *Robbins LJ, Swanner ED, Lalonde SV, Eickhoff M, Paranich ML, Reinhard CT, Peacock CL, Kappler A and KO Konhauser. "Limited Zn and Ni mobility during simulated Iron Formation diagenesis." (2015) *Chemical Geology*, 402:30-39.

11. Swanner ED, Mloszewska AM, Cirpka OA, Schoenberg R, Konhauser KO and A Kappler. "Modulation of oxygen production in Archaean oceans by episodes of Fe(II) toxicity." (2015) *Nature Geoscience*. 8(2):126-130.

10. Melton ED, Swanner ED, Behrens S, Schmidt C and A Kappler. "The Interplay of Microbially Mediated and Abiotic Reactions in the Biogeochemical Fe Cycle." (2014) *Nature Reviews Microbiology*. 12:797-808.

9. *Wu W, Swanner ED, Hao L, Zeitvogel F, Obst M, Pan Y and A Kappler. "Characterization of the physiology and cell-mineral interactions of the marine anoxygenic phototrophic Fe(II)-oxidizer *Rhodovulum iodosum* - implications for Precambrian Fe(II) oxidation." (2014) *FEMS Microbiology Ecology*. 88:503-515.

8. Swanner ED, Planavsky NP, Lalonde SV, Robbins LJ, Bekker A, Rouxel OJ, Kappler A, Mojzsis SJ and KO Konhauser. "Cobalt and marine redox evolution." (2014) *Earth & Planetary Science Letters*. 390:253-263.

7. Swanner ED, Cates N, Pecoits E, Bekker A, Konhauser KO and SJ Mojzsis. "Geochemistry of pyrite from diamictites of the Boolgeeda Iron Formation, Western Australia with implications for the GOE and Paleoproterozoic ice ages." (2013) *Chemical Geology*. 362:131-142
6. Posth NR, Köhler I, Swanner ED, Schröder C, Wellman E, Binder B, Konhauser KO, Neumann U, Berthold C, Nowak M and A Kappler. "Simulating Precambrian banded iron formation diagenesis." (2013) *Chemical Geology*. 362:66-73.
5. Swanner ED and AS Templeton. "Potential for nitrogen fixation and nitrification in the granite-hosted subsurface at Henderson Mine, CO." (2011) *Frontiers in Extreme Microbiology*. 2, doi: 10.3389/fmicb.2011.00254.
4. Swanner ED, Nell RM, and AS Templeton. "*Ralstonia* species mediate Fe-oxidation in circumneutral, metal-rich subsurface fluids of Henderson Mine, CO." (2011) *Chemical Geology*. 284: 339-350.
3. Benardini J, Vaishampayan P, Schwendner P, Swanner E, Fukui Y, Osman S, Satomi M and K Venkateswaran. "*Paenibacillus phoenicis* sp. nov. a spore forming bacterium isolated from the Phoenix Lander assembly facility." (2010) *Int. J. Syst. Env. Microbiol.* 61(6):1338-43.
2. Mayhew LE, Swanner ED, Templeton AS, Martin AP. (2008) "Phylogenetic relationships and functional genes: distribution of a manganese-oxidizing gene (mnxG) in *Bacillus* species." *Applied & Environmental Microbiology*. 74(23): 7265-7271.
1. Sahl JW, Schmidt R, Swanner ED, Mandernack KW, Templeton AS, Kieft TL, Smith RL, Sanford WE, Callaghan RL, Mitton JB, Spear JR. (2008) "Subsurface Microbial Diversity in Deep-Granitic-Fracture Water in Colorado." *Applied & Environmental Microbiology*. 74(1): 143-152.

Invited Presentations

2020

35. Swanner ED. "Updates and insights from monitoring CyanoHABs in Iowa's lakes with multi-wavelength fluorescence." EPA Great Plains and Midwest Harmful Algal Blooms Conference. Feb. 5, 2020.

2019

34. Swanner ED. "The story of iron in Iowa's lakes and why it matters." Seminar at University of Iowa, Civil and Environmental Engineering. November 15, 2019.

33. Swanner ED, Wittkop C, Lambrecht N, Katsev S, and A Picard. "Records of life in a ferruginous ocean: lessons from meromictic lakes". Geological Society of America Meeting, Phoenix, AZ. September 22-25, 2019.

32. Swanner ED. "How iron cycling in lakes informs our understanding of the greater terrestrial iron cycle." Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, Guizhou, China. July 25, 2019.

31. Swanner ED. "How iron cycling in lakes informs our understanding of the greater terrestrial iron cycle." Guangdong Institute of Eco-environmental Science & Technology, Guangzhou, Guangdong, China. July 22, 2019.

30. Swanner ED. "Tracking cyanoHABs with chlorophyll fluorescence." Environmental Protection Agency, Region 7 office. May 9, 2019.

2018

29. Swanner ED. "The importance of ferruginous systems on Earth – past and present." Seminar at University of Cologne, Germany. December 5, 2018.

28. Swanner ED, Lambrecht N, Wittkop C, Katsev S, Fakraee M, and C Sheik. "The biogeochemistry of ferruginous lakes and past ferruginous oceans. Keynote presented at Geological Society of America Meeting, Indianapolis, IN. November 4-7, 2018.

27. Swanner ED. "Photosynthesis under the anoxic and iron-rich conditions of Early Earth." Seminar at University of Minnesota, Plant and Microbial Biology. October 17, 2018.

26. Swanner ED, *Lambrecht N, Fakraee N, Sheik C, Katsev S, and C Wittkop. "Microbes and minerals from two ferruginous lakes on a spectrum of anthropogenic impacts." Keynote presented at Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.

25. Swanner ED. "Relevance of stratified Midwestern lakes to past, present, and future microbial biogeochemistry." American Chemical Society, New Orleans, LA. March 18-21, 2018.

24. Swanner, ED. "Chemically-stratified Midwestern lakes are relevant to Precambrian AND modern global biogeochemistry." University of Michigan, Department of Earth and Environmental Sciences, John A. Dorr Memorial Lecture, March 9, 2018.

2017

23. "Micronutrients matter: the role of iron in harmful algal blooms", Friends of Lakeside, Lakeside Laboratory, Milford, IA. Aug. 15, 2017.

2016

22. "Establishment of early ocean analogs in Midwestern ferruginous lakes: keys to the evolution of biogeochemical Fe cycling", Geological Society of America, Denver, CO. Sept. 26, 2016.

21. "The role of ferrous iron in oxidation of Earth's atmosphere and oceans", University of Minnesota, Department of Earth Sciences. May 5, 2016.

20. Gordon Geobiology Conference, Invited chair of "Metals as biogeochemical proxies" session, Galveston, TX. Feb. 2016.

19. "The role of ferrous iron in oxidation of Earth's atmosphere and oceans", Northwestern University, Department of Earth & Planetary Sciences. Jan. 8, 2016.

2015

18. "The role of ferrous iron in oxidation of Earth's atmosphere and oceans", University of Iowa, Department of Earth & Environmental Sciences. Nov. 6, 2015.

17. "The role of ferrous iron in oxidation of Earth's atmosphere and oceans", Indiana University-Purdue University, Indianapolis, Department of Earth Sciences, Oct. 12, 2015.

2015 and earlier (prior to ISU start)

16. "Iron isotopes as tracers of microbial and redox processes", University of Tübingen, Zentrum für Angewandte Geowissenschaften Seminar, June 12, 2015.

15. "The role of Fe in modulating Earth's oxygenation", Origin of Life Symposium, University of Göttingen. Oct. 17, 2014.

14. "Toxic levels of Fe(II) in Archean seawater delayed the Great Oxidation Event", Goldschmidt Geochemical Conference, Sacramento, CA. June 13, 2014.

13. "The trace element composition of anoxic oceans and their effect of on biogeochemical cycles", Biosignatures 2014 Conference, University of Bergen, Norway. May 21, 2014.

12. "Did Archean environmental conditions limit oxygen production by early cyanobacteria?", University of New Mexico, Department of Earth and Planetary Sciences. March 2014.

11. "Did Archean environmental conditions limit oxygen production by early cyanobacteria?", University of California, Los Angeles, Department of Earth, Planetary and Space Sciences. Feb. 2014.

10. "Did Archean environmental conditions limit oxygen production by early cyanobacteria?", Dartmouth College, Department of Earth Sciences. Jan. 2014.

9. "Did Archean environmental conditions limit oxygen production by early cyanobacteria?", Mount Holyoke College, Department of Geology and Program in Biochemistry. Jan. 2014.

8. "Did Archean environmental conditions limit oxygen production by early cyanobacteria?", Iowa State University, Department of Geological and Atmospheric Sciences. Jan. 2014.

7. "How we can use modern bacteria to understand ancient environments", Roundtable discussion for Priority Program on Early Earth (DFG SPP), University of Cologne, Germany. July 2013.

6. "Examining the relationship between oxygenic photosynthesis and Fe(II) oxidation", University Pierre & Marie Curie-IMPMC, Paris, France. March 2013.

5. "Examining the relationship of oxygenic photosynthesis to iron oxidation," Gordon Research Seminar in Geobiology, Ventura, CA. Jan. 2013.

4. "Microbially-mediated geochemical cycling of iron and nitrogen within the granite-hosted subsurface of Henderson Mine, CO", Colorado School of Mines, Golden, CO. Jan. 2013.

3. "Co-evolution of the microbial biosphere and geosphere: evidence from sediments, microbes and simulations", University of Delaware, Department of Geological Sciences. Nov. 2012.

2. "Investigation of a Terrestrial Subsurface Biosphere at Henderson Mine, CO", Florissant Scientific Society, Boulder, CO. 2010.

1. "Effective lesson planning for teaching assistants", Graduate Teacher Program Intensive, University of Colorado. 2009.

Refereed Presentations from Major Conferences

*denotes student author and advisee of Swanner

2020

67. *Islam R, and ED Swanner. "Constraining the intermediate sulfur species involved in sedimentary pyrite formation." Goldschmidt Geochemistry Conference, Honolulu, HI. *To be presented June 2020.*

66. Romaniello SJ, Gilleaudeau GJ, Swanner ED, Wittkop CA and X Chen. "U(VI) reduction in an oligotrophic ferruginous ocean analog?" Goldschmidt Geochemistry Conference, Honolulu, HI. *To be presented June 2020.*

65. Swanner ED. "What can subsurface chlorophyll maximum layers (SCML) tell us about productivity in ferruginous oceans?" Goldschmidt Geochemistry Conference, Honolulu, HI. *To be presented June 2020.*

64. Swanner ED. "Linking post-glacial (hydro)geology to redox geochemistry and ecology of midwestern lakes." North Central Geological Society of America, Duluth, MN. *To be presented May 2020.*

63. *Islam R, and ED Swanner. "Uncovering the intermediates in pyrite formation under ferruginous conditions." North Central Geological Society of America, Duluth, MN. *To be presented May 2020.*

62. *Ledesma G, Wittkop C, Lanza N, and ED Swanner. "Classification of Terrestrial Manganese Enrichments by Laser-induced breakdown spectroscopy with relevance for Gale crater, Mars." North Central Geological Society of America, Duluth, MN. *To be presented May 2020.*

61. *Beeck JB, Rasmussen M, and ED Swanner. "Pedogenic carbonate concretions in Iowa's loess soils: a modern carbon sink? North Central Geological Society of America, Duluth, MN. *To be presented May 2020.*

60. Niedzielski B, Wittkop C, Swanner E, Fralick P, and S Poulton. "Evaluating mechanisms for manganese enrichments in the Proterozoic Animikie Basin." North Central Geological Society of America, Duluth, MN. *To be presented May 2020.*

59. *Ledesma G, ED Swanner, N Lanza, C Wittkop, RC Wiens, SM Clegg, A Reyes-Newell, PJ Gasda, D DeLapp. "Analysis of Manganese-rich terrestrial sediments by laser-induced breakdown spectroscopy to elucidate the formation of Mn-enrichments in Gale crater, Mars." Lunar and Planetary Science Conference, Houston, TX. *To be presented March 2019.*

2019

58. *Ledesma G, ED Swanner, and N Lanza. "Analysis of Mn-rich lake sediments by laser induced breakdown spectroscopy to elucidate the formation of Mn-enrichments in Gale crater, Mars." National Conference on Undergraduate Research, Bozeman, MT. *To be presented March 2019.*

57. *Leung T, and ED Swanner. "Determining the role of iron in cyanoHABs and photosynthesis in Midwestern lakes." American Geophysical Union, San Francisco, CA. *To be presented December 2019.*

56. *Islam R, and ED Swanner. "Microscale resolution on how sedimentary pyrite forms." Great Plains Limnology Conference, Ames, IA. October 19, 2019.

55. *Leung T, and ED Swanner. "Lake monitoring with multi-wavelength fluorescence: insight into phytoplankton community and their health." Great Plains Limnology Conference, Ames, IA. October 19, 2019.

54. Wittkop C, Swanner ED, *Lambrecht N, Grengs A, and S Katsev. "Is methane oxidation a viable pathway for manganese carbonate genesis?" Goldschmidt Geochemistry Conference, Barcelona, Spain. August 23, 2019.

53. *Lambrecht N, and ED Swanner. "Bio-physical controls on the methane flux from ferruginous meromictic lakes in the Midwest." Association for the Sciences of Limnology & Oceanography Aquatic Sciences Meeting, San Juan, PR. February 23-March 2, 2019.

52. *Leung T, and ED Swanner. "Multi-wavelength fluorescence: a rapid method to track Harmful Algal Blooms in Iowa's agriculturally impacted lakes." Association for the Sciences of Limnology & Oceanography Aquatic Sciences Meeting, San Juan, PR. February 23-March 2, 2019.

2018

51. *Ledesma G, and ED Swanner. "Loading filter samples and embedding sediment cores under anoxic conditions for analysis use." SACNAS National Conference, San Antonio, TX. October 11-13, 2018.

50. Cole DB, Longley M, Wilkes D, Wang X, Swanner ED, Wittkop CA, Sperling EA, and NJ Planavsky. "Uranium isotope fractionation factors in ferruginous settings." Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.

49. Wittkop C, Swanner ED, *Lambrecht N, Grengs A, Myrbo A, and S Katsev. "Are manganese carbonates linked to methane oxidation?" Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.

48. *Lambrecht N, Wittkop C, Katsev S, Fakraee M, Sheik C, and ED Swanner. "Two ferruginous Midwestern lakes exhibit vastly different fluxes of methane." Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.

47. *Leung T and ED Swanner. "Dissolved Iron as a Driving Factor of Cyanobacterial Harmful Algal Blooms (CyanoHABs)." Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.

46. Swanner ED, Webb S, and A Kappler. "Fate of Cobalt and Nickel during diagenetic pyrite formation." Goldschmidt Geochemistry Conference, Boston, MA. August 12-17, 2018.
45. *Nolte D, and E Swanner. "Using DNA-based techniques to detect phytoplankton in lake ice." Symposium on Undergraduate Research & Creative Expression, Iowa State University, Ames, IA. April 10, 2018.
44. *Fatka M, and E Swanner. Title: TBD. Symposium on Undergraduate Research & Creative Expression, Iowa State University, Ames, IA. April 10, 2018.
43. Swanner E, Harding C, and C Wittkop. "The elemental consequences of lake stratification and implications for urban lakes in the upper Midwest." North-Central Geological Society of America Meeting, Ames, IA. April 15-17, 2018.
42. G Crews, BE Caissie, and E Swanner. "Assessing the Prevalence of Sub-Ice Productivity in Iowa Lakes." North-Central Geological Society of America Meeting, Ames, IA. April 15-17, 2018.
41. *Lambrecht N, and E Swanner. "Microbial communities of two Archean ocean analogs." North-Central Geological Society of America Meeting, Ames, IA. April 15-17, 2018.
40. *Leung T, and E Swanner. "The role of benthic iron during Cyanobacterial Harmful Algal Blooms (CyanoHABs) occurrences." North-Central Geological Society of America Meeting, Ames, IA. April 15-17, 2018.
39. *Atchison ED, *Leung T, and E Swanner. "Is Iron Shuttling a Driver of Harmful Algal Blooms in East and West Okoboji Lake, I.A.?" Iowa Water Conference, Ames, IA. March 21-22, 2018. (note: second place student poster prize)
38. *Leung T, and E Swanner. "Does iron stimulate Cyanobacterial Harmful Algal Bloom (CyanoHAB) in Okoboji Lake, IA?" Iowa Water Conference, Ames, IA. March 21-22, 2018. (invited talk)
37. Swanner ED. "Relevance of stratified Midwestern lakes to past, present, and future microbial biogeochemistry." American Chemical Society, New Orleans, LA. March 18-21, 2018.
36. ED Swanner, C Wittkop, S Katsev, *N Lambrecht. "The untapped potential for ferruginous ocean analog sites in lakes of the upper Midwest, U.S.A." Gordon Research Conference in Geobiology, Galveston, TX. Jan. 21-25, 2018.
35. *N Lambrecht, ED Swanner, C Sheik, C Wittkop, S Katsev. "The microbial community of a ferruginous, meromictic lake in Minneapolis, MN." Gordon Research Conference in Geobiology, Galveston, TX. Jan. 21-25, 2018.

2017

34. ED Swanner. "The role of "Oxic Fe(III) reduction" in the Archean iron cycle." Midwest Geobiology Meeting, Indianapolis, IN. Sept. 30, 2017.

33. *T Leung and ED Swanner. "Does benthic iron shuttling promote the occurrence of cyanobacterial Harmful Algal Blooms (cyanoHABs)?" Midwest Geobiology Meeting, Indianapolis, IN. Sept. 30, 2017.
32. *N Lambrecht, ED Swanner, S Katsev, C Wittkop, C Sheik. "Two newly documented ferruginous lakes in the Midwest, USA are Archean ocean analogs." Midwest Geobiology Meeting, Indianapolis, IN. Sept. 30, 2017.
31. C Wittkop, E Swanner, N Lambrecht, S Katsev, A Grengs, D Widman. "Controls on iron- and manganese-mineral solubility in ferruginous lakes." Geological Society of America, Seattle, WA. Oct. 22-25, 2017.

2016

30. *N Lambrecht, ED Swanner, C Wittkop, C Sheik, and S Katsev. "The Isolation of a Novel Photoferrotroph from Brownie Lake Provides a Mechanism for Studying the Iron Biogeochemical Cycle of a Pre-Oxic Earth." American Society for Microbiology North Central Branch Meeting, Ames, IA. Oct. 21-22, 2016.
29. *T Leung and ED Swanner. "Assessing the Role of Ferrous Iron in the Formation of Harmful Algal Blooms in Okoboji Lake, Iowa." Iowa Water Conference, Ames, IA. March 21-22, 2017.
28. C Wittkop, ED Swanner, *N Lambrecht, S Katsev. "Dissolved inorganic carbon isotope signatures in ferruginous lakes: new insights into ancient carbon isotope excursions." American Geophysical Union, San Francisco, CA. Dec. 12-16, 2016.
27. *S Eroglu, ED Swanner, S Pascarelli, R Schoenberg, H Taubald, and NJ Beukes. „Iron Speciation and Iron Isotopes of Neoproterozoic Ca-Mg Carbonates." Goldschmidt Geochemical Conference, Yokohama, Japan. June 26-July 1, 2016.
26. *S Eroglu and ED Swanner. "Iron systematics of Late Archean tidal flats." Gordon Research Conference in Geobiology, Galveston, TX, Jan. 31-Feb. 5, 2016.

2015

25. *M Maisch, *W Wu, A Kappler, and ED Swanner. "Laboratory-scale simulation of Precambrian ocean Fe(II)-rich upwelling: implications for cyanobacteria and oxygen production." Midwest Geobiology Meeting, Bloomington, IN. Oct. 10, 2015.
24. ED Swanner. "Fe isotopes as tracers of Fe biomineralization processes and intermediates formed by phototrophic organisms." Midwest Geobiology Meeting, Bloomington, IN. Oct. 10, 2015.

2015 and earlier (prior to ISU start)

23. *Bayer T, *Wu W, Kappler A, Schoenberg R, and ED Swanner. "Fe isotope fractionation during Fe(II) oxidation by cyanobacteria." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 16-21, 2015.

22. Eroglu S, Schoenberg R, van Zuilen M, Taubald H, Swanner ED, and N Beukes. "The geochemical and isotopic record of a Neoproterozoic oxygen oasis." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 16-21, 2015.
21. *Maisch M, *Wu W, Kappler A, and ED Swanner. "A laboratory-scale column to investigate Archean, Fe(II)-rich upwelling systems." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 16-21, 2015.
20. *Halama M, Swanner ED, A Kappler. "Carbon isotope fractionation of organic carbon during simulated diagenesis of banded iron formations." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 16-21, 2015.
19. *Halama M, Swanner ED, and A Kappler. "Fate of organic carbon and primary iron minerals during simulated diagenesis of banded iron formations." Goldschmidt Geochemical Conference, Sacramento, CA. June 8-13, 2014.
18. Swanner ED, Mloszewsa AM, Konhauser KO, Schoenberg R, and A Kappler. "Toxic levels of Fe(II) in Archean seawater delayed the Great Oxidation Event." Goldschmidt Geochemical Conference, Sacramento, CA. June 8-13, 2014.
17. *Wu W, Swanner ED, Pan Y, and A Kappler. "Physiological and Mineralogical Characterization of Fe(II) Oxidation by a Marine Photoferrotroph." German Mineralogical Society meeting, Tübingen, Germany. Sept. 15-18, 2013.
16. Swanner ED, Wu W, Schoenberg R, and A Kappler. "Iron: a secular control on biologically-driven oxidation." German Mineralogical Society meeting, Tübingen, Germany. Sept. 15-18, 2013.
15. *Wu W, Swanner ED, Pan Y, Schoenberg R, and A Kappler. "Fe(II) oxidation of a marine photoferrotroph and implications of its role in the deposition of Precambrian BIFs." Goldschmidt Geochemical Conference, Florence, Italy. Aug. 25-30, 2013.
14. Swanner ED, *Wu W, Voelker B, Schoenberg R, and A Kappler. "The quantitative contribution of oxygenic photosynthesis to Fe(II) oxidation in Precambrian oceans." Goldschmidt Geochemical Conference, Florence, Italy. Aug. 25-30, 2013.
13. ED Swanner, A Bekker, N Cates, E Pecoits, KO Konhauser, and SJ Mojzsis. Geochemistry of pyrite from diamictites of the Hamersley Basin, Western Australia with implications for the GOE and Paleoproterozoic ice ages. European Geosciences Union, Vienna, Austria. April 7-12, 2013.
12. ED Swanner, NJ Planavsky, S Lalonde, LJ Robbins, A Bekker, O Rouxel, KO Konhauser, and SJ Mojzsis. "Sedimentary Cobalt Concentrations track marine redox evolution." European Geosciences Union, Vienna, Austria. April 7-12, 2013.
11. ED Swanner, NJ Planavsky, S Lalonde, LJ Robbins, A Bekker, O Rouxel, KO Konhauser, and SJ Mojzsis. "Sedimentary Cobalt Concentrations track marine redox evolution." Gordon Research Conference in Geobiology, poster, Ventura, CA. Jan. 27- 31, 2013.
10. KO Konhauser, Robbins LJ, Eickhoff M, Swanner ED, and A Kappler. "Banded Iron Formation as Seawater Proxies." Goldschmidt Geochemical Conference, Montreal, Quebec. June 24-29, 2012.

9. Swanner ED and A Kappler. "Cyanobacteria and photoferrotrophs: together again?" Goldschmidt Geochemical Conference, Montreal, Quebec. June 24-29, 2012.
8. Pecoits E, Swanner ED, Cates NL, Konhauser KO, and Mojzsis. "Trace metal abundances in banded iron-formation sulfides track secular changes in microbial community structure with progressive oxidation." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 14-19, 2011.
7. ED Swanner and AS Templeton. "A Microbially-mediated Deep Terrestrial Nitrogen Cycle at Henderson Mine, CO." Goldschmidt Geochemical Conference, Prague, Czech Republic. Aug. 14-19, 2011.
6. ED Swanner. "Early hydrogen production on carbonaceous asteroids could support subsurface life." Astrobiology Graduate Conference (AbGradCon), Bozeman, MT. June 4-8, 2011.
5. Swanner ED, Nell RM, and AS Templeton. "*Ralstonia* species mediate Fe-oxidation in the deep biosphere of Henderson Mine." Goldschmidt Geochemical Conference, Knoxville, TN. June 13-18, 2010.
4. ED Swanner, N Cates, E Pecoits, KO Konhauser, and SJ Mojzsis. "Multiple sulfur isotopes and trace elements in Precambrian sedimentary sulfides reflect shifting microbial communities during the GOE." Gordon Research Conference in Geobiology, Ventura, CA. Jan. 30-Feb. 4, 2011.
3. Mojzsis SJ, Van Kranendonk MJ, and ED Swanner. "Microbial community structure and atmospheric oxygen ca. 2.4 Ga. Goldschmidt Geochemical Conference, Davos, Switzerland. June 21-26, 2009.
2. Swanner ED and AS Templeton. "Subsurface iron cycling by a single species of bacteria." Astrobiology Graduate Conference (AbGradCon), Seattle, WA. July 17-18, 2009.
1. ED Swanner and AS Templeton. "Microbially-mediated cycling of metals in deep subsurface fluids at Henderson Mine, Colorado." Goldschmidt Geochemical Conference, Vancouver, BC. July 13-18, 2008.

TEACHING EXPERIENCE

GEOL 100, The Earth, ISU, Spring 2019.

MICRO 490ES, Independent Study in Microbial Ecology, ISU, 2 students in Spring 2018.

ENSCI 483/583, Environmental Biogeochemistry, ISU, co-taught with Prof. Steven Hall, Spring 2017, 2019.

BIOL 487/EEOB 587, Microbial Ecology, ISU, Fall 2016-2020.

GEOL 419/519, Aqueous and Environmental Geochemistry, ISU, Spring 2016, 2018, 2020.

Project supervisor, Geomicrobiology Lab Course, University of Tübingen, Oct. 2013.

Teaching Geology Workshops, Presenter and Facilitator. 2008 & 2009.

Geology Lead Graduate Teacher, Graduate Teacher Program, CU-Boulder. 2008-2010.

Teaching Assistant, Introduction to Geology Laboratory, Department of Geological Sciences, CU-Boulder. 2007-2008.

Field Instructor, The Women's Wilderness Institute, Boulder, CO. 2005.

Field Instructor, Four Corners School of Outdoor Education, Monticello, UT. 2003.

Field Instructor, Outward Bound West, UT and CO. 2003-2005.

STUDENTS AND TRAINEES

Kaleigh Block, MS student in Geology Program and Environmental Sciences Graduate Program, ISU, 2020-present.

Zackry Stevenson, PhD student in Interdepartmental Microbiology Program, ISU, 2020-present.

Raisa Islam, MS student in Geology Program and Environmental Sciences Graduate Program, ISU, 2019-present.

Dr. Hui Tong, Visiting Scholar (China Scholarship Council) in Dept. of Geological & Atmospheric Sciences, ISU, 2018-2020.

Micah Fatka, MS student in Geology Program and Environmental Sciences Graduate Program, ISU, 2018-present.

Tania Leung, PhD student in Geology Program and Environmental Sciences Graduate Program, ISU, 2016-present.

Nick Lambrecht, postdoc, ISU, 2019-present; formerly PhD student in Interdepartmental Microbiology Program, ISU, 2016-2019.

ISU Undergraduates: Cristina Santana (2015-2016), William McNamara (2016), Megan Greenlee (First year honors project; 2016), Erin Atchison (Iowa Space Grant Scholarship mentor; 2017-2018), Raisa Islam (Mt. Holyoke summer intern, 2017), Matthew Pronschinske (Honors thesis mentor; 2017-2018), Anna Drahos (2018), Micah Fatka (490: 2018), Danika Nolte (490: 2018), Anthony Davis (2018), Garrett Crews (490 with Beth Caissie: 2018), Gabbie Ledesma (LAS Dean's High Impact Award, Iowa Space Grant Scholarship mentor; 2018-present), Jazlyn Beeck (First year honors project, LAS Dean's High Impact Award; 2019-present), Brinlee Geyer (2019), Tamara McConnell (2020), William Manriquez (McNair Scholar; 2020)

Sümeyya Eroglu, PhD Fulbright Fellow at ISU (during PhD at University of Tuebingen), January-July 2016 (currently an Assistant Professor at University of Muenster).

Markus Maisch, supervised MS project at ISU/University of Tuebingen, 2015-2016 (subsequently finished a PhD at University of Tuebingen).

Wenfang Wu, supervised postdoc project at University of Tuebingen, 2014-2016 (currently a science teacher at English language school in Beijing, China).

Max Halama, supervised PhD project at University of Tuebingen, 2013-2016 (currently working in industry in Germany).

SERVICE ACTIVITIES

Journal Reviews

American Mineralogist (1), Applied Geochemistry (1), Astrobiology (2), Biogeochemistry (2), Chemical Geology (3), Economic Geology (1), Environmental Pollution (1), Environmental Science & Technology (5), Frontiers (2), Geobiology (9), Geochemistry: Exploration, Environment, Analysis (1), Geochimica et Cosmochimica Acta (4), Geology (3), International Society of Microbial Ecology (1), Journal of Environmental Monitoring (1), Nature Communications (3), Nature Geoscience (1), Science (1), Scientific Reports (1).

Verified Publons reviews since ISU start (Aug. 2015): 42 (publons.com/a/1333184/)

Proposal Reviewer or Panelist

American Chemical Society-Petroleum Research Fund, Fonds de Recherche du Quebec, Iowa Space Grant, the National Aeronautics and Space Administration (NASA) Solar Systems, the National Science Foundation (NSF) Antarctic Organisms and Ecosystems, NSF Geochemistry and Low-Temperature Geobiology, NSF Marine Chemistry and Geochemistry, the Natural Sciences and Engineering Research Council (NSERC – Canada), the Research Institute of the University of Bucharest, the Stanford Synchrotron Radiation Lightsource.

Conference Organization and Session Convener

Co-convener, Session on microbes, North Central Geological Society of America Meeting (virtual), May 2020.

Organizer, Great Plains Limnology Conference, October 2019.

Co-convener, Session on biology of modern analogues, Goldschmidt Geochemistry Conference, August 2018.

Co-convener, Biogeochemistry session, North Central Geological Society of America Meeting, April 2018.

Exhibits Chair, 2018 North Central Geological Society of America Meeting, April 2018.

Co-convener, Session on Biogeochemical cycling of iron, manganese, sulfur, and chromium for Goldschmidt Geochemistry Conference, June 2016.

Co-convener, Session on early Earth analogues for Goldschmidt Geochemistry Conference, August 2015.

Co-convener, Session on microbe-mineral interactions for German Mineralogical Society, September 2013.

Co-convener, Session on ferruginous settings for Goldschmidt Geochemistry Conference, August 2013.

Co-convener, Session on Early Earth for European Geosciences Union, April 2013.

Chairperson & Education and Public Outreach Coordinator, Astrobiology Graduate Conference, Montana State University, Bozeman. 2009-2011.

Departmental and University Service

Department of Geological and Atmospheric Sciences

Diversity, Equity and Inclusion Committee (Chair). 2020-present.

Faculty Evaluations Committee. 2019-present.

Awards Committee. 2019-2020.

Search Committee, Sedimentary Geologist, 2018-2019.

Advisory committee to the chair. 2018-2020.

Geology Banquet Committee. 2017-2018.

Geology Curriculum Committee. 2016-2020.

Ronald Lecture Committee. 2016-2018.

Geology Space Committee (Chair). 2016-present.

Geology Graduate Student Admissions Committee. 2015-2018.

Iowa State University

Environmental Sciences Graduate Student Organization Advisor. 2016-present.

Microbiology Graduate Student Organization Advisor. 2018-2019.

Outreach

Co-wrote "Brownie Lake" Wikipedia entry, October 2018.

Established "Ferruginous Lakes" YouTube channel with videos about research, October 2018.

Maintain ISU Geology Facebook page, 2018-present.

Advisor of award-winning Astrobiology project for Iowa Junior Academy of Science and State Science & Technology Fair of Iowa, 2018.

Workshop Leader, ISU Program for Women in Science in Engineering (PWISE), October 2016-2019.

Workshop Organizer, ISU Youth 4H conference, June 2016-2019.

Mentor, Goldschmidt Geochemistry Conference, June 2014.

Blogger, European Association of Geochemistry, 2013-2015.

Instructor, Children's University: Microbiology, University of Tuebingen, July 2013.

Scientific Writing & Illustrator Workshops, University of Tuebingen. 2012 & 2013.

Invited Representative, University of Tuebingen's application for Excellence Funding. 2012.

"A metabolically-versatile bacterium thrives in granitic rock of the deep subsurface." Dance Your PhD Contest Entry, Sponsored by Science/AAAS. 2010.

Field Trip Leader, Geology Summer Field Series, CU-Boulder, CO. 2010.

Organizer, Geology Graduate Student Poster Session, CU-Boulder, CO. 2010.

Editor, Matriculation Guide for Incoming Graduate Students, Department of Geological Sciences, CU-Boulder, CO. 2010.

Compiler, Online Resources for TAs of Geology 1030, Department of Geological Sciences, CU-Boulder, CO. 2009.