Christopher A. Gorski

Assistant Professor of Civil & Environmental Engineering

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Areas of Expertise

Environmental redox chemistry, aquatic geochemistry, environmental electrochemistry, environmental mineralogy, salinity gradient energy, capacitive mixing, mineral transformation reactions, contaminant fate in groundwater systems, role of minerals in organic carbon cycling, hydraulic fracturing

Appointments

08/2012 – present Assistant Professor, Department of Civil & Environmental Engineering, Pennsylvania State University, University Park, PA

Professional Preparation

Purdue University	Civil Engineering	B.S., 2005
University of Iowa	Environmental Engineering & Science	Ph.D., 2009
Eawag	Environmental Chemistry	Post-doc, 2010-2012

Funded Research Projects

SusChem: Manganese oxide supercapacitor charging/discharging mechanisms to capture energy using capacitive mixing (CapMix). (PI: Gorski, C.A.; Co-PI: Logan, B.E.) National Science Foundation: CBET Environmental Engineering. August 2016 – July 2019. $330,000.

pH-gradient flow batteries for generating electricity from waste CO_2 streams. (PI: Gorski, C.A.; Co-PI: Logan, B.E.) MRI-PSIEE Seed Proposal - Convergence between Materials and Energy**.** May 2016 – June 2016. $10,000.

INGaR: Enhanced Gas Recovery using Chemical-Mechanical Fracturing. (PI: Velegol, D.; Co-PI: Gorski, C.A.) Halliburton Energy Services. September 2015 – August 2016. $169,296.

High Pressure/High Temperature Reactor Systems for Unconventional Oil and Gas Research. (PI: Burgos, W.D.; Co-PIs: Gorski, C.A., Alger, M., Velegol, D.) Research Equipment Grant, College of Engineering Penn State University. March 2015 – February 2016. $114,230.

EAGER: SusChem: Enhanced electricity production from engineered salinity gradients using capacitive mixing. (PI: Logan, B.E.; Co-PI: Gorski, C.A.) National Science Foundation: CBET Environmental Engineering. April 2015 – December 2015. $130,000.

Chromium fate in groundwater systems: In situ investigation of chromium oxidation by manganese dioxide using electrochemical and synchrotron diffraction analyses. Penn State Institute of Energy and the Environment (PSIEE) Seed grant. (PI: Gorski, C.A.; Co-PI: Heaney, P.). March 2015 – December 2015. $25,000.

Collaborative Research: Recrystallization of Stable Iron Oxides in Reducing Environments. (PI: Gorski, C.A.; Co-PI: Fantle, M.S.). National Science Foundation: EAR Geobiology and Low-temp geochemistry. August 2015 – July 2017. $199,941.

Evaluate the Role of Fe-rich Mineral Phases in Controlling Tracer/ Contaminant Behavior. (PI: Burgos, W.D.; Co-PI: Gorski, C.A.). Department of Energy: National Energy Technology Laboratory. November 2013 – November 2014. $69,200.

Geochemical transformations caused by CO_2 injection or leakage. (PI: Burgos, W.D.; Co-PI: Gorski, C.A.). Department of Energy: National Energy Technology Laboratory November 2012 – March 2014. $111,450.

Redox reactivity of iron-bearing clay minerals. (PI: Gorski, C.A.) National Science Foundation: International Research Fellowship Program (IRFP). 2010. Amounted awarded: $139,500. (Awarded but declined due to an alternative funding source).

Awards & Honors

Emmert H. Bashore Faculty Development Professorship. 2012–2014. Pennsylvania State University, University Park, PA.

Telluride Science Research Center's Peter Salamon Award for Young Scientists. 2012. Telluride, CO, USA.

ACS C. Ellen Gonter Environmental Chemistry Paper Award. 2009. *For: Influence of magnetite stoichiometry on Fe^{II} uptake and nitrobenzene reduction.*

Center for Global and Regional Environmental Research (CGRIR) graduate student travel grant. 2008, 2009.

Advisee Awards

Jenelle Fortunato – Penn State College of Engineering Graduate Excellence Fellowship. Fall 2016 – Fall 2017.

Taeyoung Kim – "Electricity production from CO_2 and air in an entropic energy flow cell." Best Poster at Penn State Energy Days 2016 Conference in the Technology/Materials/Energy Storage category. May 19-20, 2016.

S. Sarah Cronk – "The role of iron minerals in preserving organic carbon during aerobic degradation." Second Place for Best Poster. Environmental Chemistry Student Symposium at Penn State. April 8-9, 2016.

Prachi Joshi – American Chemical Society (ACS) – Geochemistry division student Travel award for the 2016 Spring National Meeting in San Diego for her talk "Mineralogical Changes in Goethite during Goethite-Fe(II) Atom Exchange: a Microscopic and ^{55}Fe-Tracer Study".

Patrick Dugan – Penn State College of Engineering REU - Summer 2015.

S. Sarah Cronk – Penn State College of Engineering Graduate Excellence Fellowship. Fall 2014 – Fall 2017.

Aron Griffin – Penn State College of Engineering REU - Summer 2014.

Rebecca Edwards – NSF Graduate Research Fellowship (Awarded 2014).

Journal Publications

30. Gorski, C.A., Edwards, R., Sander, M., Hofstetter, T.B., Stewart, S.M. (2016). Thermodynamic characterization of iron oxide - aqueous Fe^{2+} redox couples. *Environmental Science & Technology*. In press.
29. Joshi, P., Gorski, C.A. (2016). Anisotropic morphological changes in goethite during Fe^{2+}-catalyzed recrystallization. *Environmental Science & Technology*. 50:7315-7324.
28. Tomaszewski, E.J., Cornk, S.S., Gorski, C.A., Ginder-Vogel, M. (2016). The role of dissolved Fe(II) concentration in the mineralogical evolution of Fe (hydr)oxides during redox cycling. *Chemical Geology*. In press.
27. Kar, A., McEldrew, M., Stout, R.F., May, B.E., Khair, A., Velegol, D., Gorski, C.A. (2016). Self-Generated Electrokinetic Fluid Flows during Pseudomorphic Mineral Replacement Reactions. *Langmuir*. 32:5233-5240.
26. Wu, T., Griffin, A.M., Gorski, C.A., Shelobolina, E.S., Xu, H., Kukkadapu, R.K., Roden, E.E. (2016). Interactions between Fe(III)-oxides and Fe(III)-phyllosilicates during microbial reduction 2: Natural subsurface sediments. *Geomicrobiology Journal*. *Accepted.*
25. Kim, T., Rahimi, M., Logan, B.E., Gorski, C.A. (2016). Evaluating battery-like reactions to harvest energy from salinity differences using ammonium bicarbonate salt solutions. *ChemSusChem*. 9:981-988.
24. Zhu, X., Rahimi, M., Gorski, C.A., Logan, B.E. (2016). A thermally-regenerative ammonia-based flow battery for electrical energy recovery from waste heat. *ChemSusChem*. 9:873-879.
23. Wu, T., Kukkadapu, R.K., Griffin, A.M., Gorski, C.A., Konishi, H., Xu, H., Roden, E.E. (2016). Interactions between Fe(III)-oxides and Fe(III)-phyllosilicates during microbial reduction 1: Synthetic sediments. *Geomicrobiology Journal. In press.*
22. O'Loughlin, E.J., Gorski, C.A., Scherer, M.M. (2015). Effects of Phosphate on Secondary Mineral Formation during the Bioreduction of Akaganeite (β-FeOOH): Green Rust versus Framboidal Magnetite. *Current Inorganic Chemistry*. 5:214-224. *(Invited paper).*
21. Sander, M., Hofstetter, T.B., Gorski, C.A. (2015). Electrochemical Analyses of Redox-Active Iron Minerals: A Review of Nonmediated and Mediated Approaches. (Critical Review) *Environmental Science & Technology*. 49:5862-5878.
20. Luan, F., Gorski, C.A., Burgos, W.D. (2015). Linear Free Energy Relationships for Biotic and Abiotic Reduction of Nitroaromatic Compounds. *Environmental Science & Technology*. 49:3557-3565.
19. Luan, F., Liu, Y., Griffin, A., Gorski, C.A., Burgos, W.D. (2015). Iron(III)-Bearing Clay Minerals Enhance Bioreduction of Nitrobenzene by *Shewanella putrefaciens* CN32. *Environmental Science & Technology*. 49:1418-1426.

18. Soltermann, D., Marques Fernandes, M., Baeyens, B., Dähn, R., Joshi, P.A., Scheinost, A.C., Gorski, C.A. (2014). Fe(II) Uptake on Natural Montmorillonites. I. Macroscopic and Spectroscopic Characterization. *Environmental Science & Technology.* 48:8688-8697.

17. Luan, F., Gorski, C.A., Burgos, W.D. (2014). Thermodynamic Controls on the Microbial Reduction of Iron-Bearing Nontronite and Uranium. *Environmental Science & Technology.* 48:2750–2758

16. Gorski, C.A., Klüpfel, L., Voegelin, A., Sander, M., Hofstetter, T.B. (2013). Redox properties of structural Fe in clay minerals: 3. Relationships between Smectite Redox and Structural Properties. *Environmental Science & Technology*. 47:13477-13485.

15. O'Loughlin, E.J., Boyanov, M.I., Flynn, T.M., Gorski, C.A., Hofmann, S.M., McCormick, M.L., Scherer, M.M., Kemner, K.M. (2013). Effects of bound phosphate on the bioreduction of lepidocrocite (γ-FeOOH) and maghemite (γ-Fe_2O_3) and formation of secondary minerals. *Environmental Science & Technology*. 47:9157-9166.

14. Gorski, C.A., Klüpfel, L., Voegelin, A., Hofstetter, T.B., Sander, M. (2012). Redox properties of structural Fe in clay minerals: 2. Electrochemical and spectroscopic characterization of electron transfer irreversibility in ferruginous smectite, SWa-1. *Environmental Science & Technology*. 46:9369-9377.

13. Gorski, C.A., Aeschbacher, A., Soltermann, D., Baeyens, B., Marques, M., Hofstetter, T.B., Sander, M. (2012). Redox properties of structural Fe in clay minerals: 1. Electrochemical quantification of electron donating and accepting capacities of smectites. *Environmental Science & Technology.* 46:9360-9368.

12. Pearce, C.I., Qafoku, O., Liu, J., Arenholz, E., Heald, S.M., Kukkadapu, R.K., Gorski, C.A., Henderson, C.M.B., Rosso, K.M. (2012). Synthesis and properties of titanomagnetite ($Fe_{3-x}Ti_xO_4$) nanoparticles: A tunable solid-state Fe(II/III) redox system. *Journal of Colloid and Interface Science*. 387:24-38.

11. Latta, D.E., Gorski, C.A., Scherer, M.M. (2012). Influence of Fe^{2+}-catalyzed Fe oxide recrystallization on metal cycling. *Biochemical Society Transactions*. 40:1191-1197. *(Invited paper).*

10. Lilova, K.I., Pearce, C.I., Gorski, C.A., Rosso, K.M., Navrotsky, A. (2012). Thermodynamics of the Magnetite-Ulvöspinel (Fe_3O_4-Fe_2TiO_4) Solid Solution. *American Mineralogist*. 97:1330-1338.

9. Gorski, C.A., Handler, R.M., Beard, B.L., Pasakarnis, T., Johnson, C.M., Scherer, M.M. (2012). Fe atom exchange between aqueous Fe^{2+} and magnetite. *Environmental Science & Technology.* 46:12399-12407. *(Invited paper).*

8. Chen, H., Laskin, A., Baltrusaitis, J., Gorski, C.A., Scherer, M.M., Grassian, V.H. (2012). Coal combustion fly ash as a source of iron in atmospheric dust. *Environmental Science & Technology*. 46:2112-2120.

7. Latta, D.E., Gorski, C.A., Boyanov, M., O'Loughlin, E.J., Kemner, K.M., Scherer, M.M. (2012). Influence of magnetite stoichiometry on U^{VI} reduction. *Environmental Science & Technology*. 46:778-786.

6. Schaefer, M.V., Gorski, C.A., Scherer, M.M. (2011). Spectroscopic evidence for interfacial Fe(II)- Fe(III) electron transfer in a clay mineral. *Environmental Science & Technology*. 45:540-545.

5. O'Loughlin, E.J., Gorski, C.A., Scherer, M.M., Boyanov, M.I., Kemner, K.M. (2010). Effects of oxyanions, natural organic matter, and bacterial cell numbers on the bioreduction of lepidocrocite (γ-FeOOH) and the formation of secondary mineralization products. *Environmental Science & Technology*. 44:4570-4576.

4. Gorski, C.A., Scherer, M.M. (2010). Determination of nanoparticulate magnetite stoichiometry by Mössbauer spectroscopy, acidic dissolution, and powder X-ray diffraction: A critical review. *American Mineralogist*. 95:1017-1026.
3. Rosso, K.M., Yanina, S.V., Gorski, C.A., Larese-Casanova P., Scherer, M.M. (2010). Connecting observations of hematite (α-Fe_2O_3) growth catalyzed by Fe(II). *Environmental Science & Technology*. 44:61-67. *(Invited paper).*
2. Gorski, C.A., Nurmi, J.T., Tratnyek, P.G., Hofstetter, T.B., Scherer, M.M. (2010). Redox behavior of magnetite: Implications for contaminant reduction. *Environmental Science and Technology*. 44:55-60. *(Invited paper).*
1. Gorski, C.A., Scherer, M.M. (2009). Influence of magnetite stoichiometry on Fe^{II} uptake and nitrobenzene reduction. *Environmental Science & Technology*. 43:3675-3680. *(Awarded the ACS C. Ellen Gontor Environmental Chemistry Paper Award, 2009).*

Peer-reviewed Book Chapters

1. Gorski, C.A., Scherer, M.M. (2011). Fe^{2+} sorption at the Fe oxide-water interface: A revised conceptual model. Chapter 15 in the ACS symposium series: Aquatic Redox Chemistry. 315-343. Editors: Tratnyek, P.; Grundel, T.; Haderlein, S. *(Invited).*

Articles in review

- Joshi, P. and Gorski, C.A. Anisotropic morphological changes in goethite during Fe^{2+}-catalyzed recrystallization. Under review in *Environmental Science & Technology*.
- Kim, T., Rahimi, M., Logan, B.E., Gorski, C.A. Entropic energy flow cell for harvesting energy from salinity differences. Under review in *Environmental Science & Technology*.
- Gorski, C.A., Edwards, R., Sander, M., Hofstetter, T.B., Stewart, S.M. Thermodynamic characterization of iron oxide - aqueous Fe^{2+} redox couples. Under review in *Environmental Science & Technology*.
- Gorski, C.A. and Fantle, M.S. Stable Mineral Recrystallization in Low Temperature Aqueous Systems: A Critical Review. Under review in *Geochimica et Cosmochimica Acta.*
- Tomaszewski, E.J., Cronk, S.S., Gorski, C.A., Ginder-Vogel, M. The role of dissolved Fe(II) concentration in the mineralogical evolution of Fe (hydr)oxides during redox cycling. Under review in *Chemical Geology.*
- Rahimi, M. Schoener, Z., Zhu, X., Gorski, C.A., Logan, B.E. Copper Removal from Industrial Wastewater Using a Thermally Regenerative Electrodeposition Battery. Under review in *Journal of Hazardous Materials.*

Invited Presentations

- Gorski, C.A. University of Delaware, Newark, Delaware. Civil and Environmental Engineering Seminar Series. 11/13/15. "Quantifying Mineral Redox Properties."

- Gorski, C.A. Goldschmidt Conference. Prague, Czech Republic. 8/16/15-8/22/15. "Radionuclide-Mineral Redox Interactions: Current Progress and Future Outlook." *(Keynote).*
- Gorski, C.A., Edwards, R., Griffin, A. Telluride Science Research Center: Biogeochemistry and Redox Transformations of Iron Workshop. Telluride, CO. 8/4/14-8/8/14. "Measuring and controlling reduction potentials in Fe oxide suspensions."
- Burgos, W., Luan, F., Gorski, C.A., Dong, H., Bishop, M. Joint DoE-TES/DoE-SBR PI Meeting. 5/6/14-5/7/14. Potomac, MD. "Reactivity of Iron-Bearing Phyllosilicates with Uranium and Chromium Through Redox Transition Zones."
- Scherer, M.M., Neumann, A., Gorski, C.A., Latta, D.E. American Chemical Society National Meeting. Indianapolis, IN. 9/8/13 - 9/12/13. "Fe(II) sorption at the Fe mineral-water interface: A new conceptual framework and its implications for metal cycling."
- Gorski, C.A., Sander, M., Hofstetter, T. Goldschmidt Conference. Florence, Italy. 8/25/13. "Mediated electrochemical analyses to characterize redox-active geochemical phases: Application to iron-bearing clay minerals."
- Hofstetter, T.B., Gorski, C.A., Voegelin, A., Sander, M. Iron Biogeochemistry - From Molecular Processes to Global Cycles Workshop. Monte Verita, Switzerland. 3/3/13 -3/8/13. "Electrochemical characterization of the redox properties of structural Fe in clay minerals."
- Gorski, C.A. Penn State University Geosciences Colloquium Series. University Park, PA. 2/5/13. "Measuring mineral redox properties."
- Hofstetter, T.B., Gorski, C.A., Voegelin, A., Sander, M. International Meeting: Clays in natural and engineered barriers for radioactive waste containment. Montpellier, France. 10/22/12-10/25/12. "The redox properties of natural Fe-bearing clay minerals: A combined electrochemical and spectroscopic study."
- Gorski, C.A., Aeschbacher, M., Voegelin, A., Klupfel, L., Sosedova, Y., Sander, M., Hofstetter, T. Telluride Science Research Center: Biogeochemistry and Redox Transformations of Iron Workshop. Telluride, CO. 8/6/12-8/10/12. "Dynamics of electron transfer to and from Fe-bearing minerals: Electrochemical characterization of redox properties."
- Latta, D., Pearce, C., Gorski, C.A., Rosso, K., O'Loughlin, E., Kemner, K., Scherer, M.M., Boyanov, M. Goldschmidt Conference. Montreal, Canada. 6/29/12. "Reactivity of U(VI) with pure, oxidized, and Ti-substituted magnetites."
- Gorski, C.A. Providence, RI. Brown University. 3/5/12. "Interfacial redox chemistry in aquatic environments: From minerals to mediators."
- Gorski, C.A. University Park, PA. Pennsylvania State University. 2/13/13. Department of Civil and Environmental Engineering. "Interfacial redox chemistry in aquatic environments: From minerals to mediators."
- Scherer, M.M., Handler, R.M., Gorski, C.A., Beard, B., Johnson, C.M., Rosso, K.M. Knoxville, TN. Goldschmidt Conference. 6/18/11. "Redox behavior of nanoscale Fe oxides: Stable isotope investigations." (*Keynote*).
- Gorski, C.A., Scherer, M.M. Iowa City, IA. Dept. of Mechanical Engineering Seminar, University of Iowa. 1/21/10. "Assessing the role of iron minerals in understanding the fate of environmental contaminants."
- Gorski, C.A., Scherer, M.M. Washington, D.C. 238th ACS National Meeting. 8/16/09-8/20/09. "New conceptual model for interpreting the redox behavior of magnetite in anoxic environments."

- Gorski, C.A., Scherer, M.M. Zurich, Switzerland. Environmental Chemistry dept., ETH, Swiss Federal Institute of Technology. 6/12/09. "Influence of magnetite stoichiometry on Fe(II) uptake and nitrobenzene reduction."
- Gorski, C.A., Scherer, M.M. Tubingen, Germany. Institute of Geosciences, Tubingen University. 6/10/09. "Influence of magnetite stoichiometry on Fe(II) uptake and nitrobenzene reduction."

Professional Memberships

- American Chemical Society (ACS) (Member, 2006–present)
- Mineralogical Society of America (MSA) (Member, 2011–present)
- Association of Environmental Engineering and Science Professors (AEESP) (Member, 2012–present)
- American Society for Engineering Education (ASEE) (Member, 2012–present)
- Clay Mineral Society (CMS) (Member, 2013–present)

Synergistic Activities

Journal Reviewer: Environmental Science & Technology, Environmental Science & Technology Letters, Geochimica et Cosmochimica Acta, The Journal of Physical Chemistry, Clays and Clay Minerals, Metals, Environmental Chemistry, Langmuir, Journal of Nanoparticulate Research, European Mineralogy Union book series.

Proposal Reviewer: U.S. National Science Foundation, Swiss National Science Foundation, Penn State Institutes of Energy and the Environment (PSIEE) Seed Grant Program, Penn State College of Engineering REU program.

Symposium Organizer:

"Creating and Exploiting Salinity Gradients." ACS National Meeting, Philadelphia, PA. August 2016. (co-organizers: Bruce Logan, Meagan Mauter).

"Redox and Radical Biogeochemistry." Goldschmidt Conference, Prague, Czech Republic. August 2015. (co-organizers: Michael Sander, Christina Remucal).

"Global Biogeochemical Cycles in the Anthropocene". Association of Environmental Engineering and Science Professors (AEESP) bi-annual conference. August 2013. (co-organizers: Drew Latta, Michelle Scherer).

"Iron redox transformations and their impact on trace elements in natural and engineered systems." Goldschmidt Conference, Florence, Italy. August 2013. (co-organizers: Andreas Voegelin, Thilo Behrends, Stephan Hug).

Outreach: Director of an annual, week-long summer science experience for grade 6-8 students titled "Water Heroes", organized through Science U at Penn State. 20-30 campers per session. 2013-present.

Current Students & Post-docs

- Jenelle Fortunato, Ph.D., in progress. 2016 – present.

- Sydney Steward, M.S., in progress. 2015 – present.
- Taeyoung Kim, Post-doc, 2015 – present. (Co-advised with B. Logan)
- Mohammad (Mim) Rahimi, Ph.D., in progress. 2015 – present. (Co-advised with B. Logan)
- S. Sarah Cronk, M.S., in progress. 2014 – present.
- Prachi Joshi, Ph.D., in progress. 2015 – present.
- Patrick Duggan, Undergrad honors thesis, in progress, 2013 – present.

Past Students & Post-docs

- Aron Griffin, Undergrad honors thesis, 2013-2015. Thesis: *Secondary mineralization of ferrihydrite under reducing redox conditions: An electrochemical study.*
- Prachi Joshi, M.S., 2013-2015. Thesis: *Morphological changes in goethite during atom exchange with aqueous* Fe^{2+}.
- Rebecca Edwards, M.S. 2013-2015. Thesis: *Measuring reduction potentials of Fe oxide – aqueous* Fe^{2+} *redox couples using mediated electrochemical techniques.* (*NSF GRFP Fellow*)