

Daniel R Hummer

Assistant Professor
School of Earth Systems and Sustainability
Southern Illinois University
Carbondale, IL 62901
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Areas of expertise: Mineralogy, Crystallography, High-Temperature Geochemistry

Professional Experience

Assistant Professor of Geology, 2016-present
Southern Illinois University, Carbondale, IL

Postdoctoral Research Associate, 2015-2016
Carnegie Institution for Science, Washington, DC

Postdoctoral Research Associate, 2012-2015
University of California Los Angeles, Los Angeles, CA

Postdoctoral Fellow, 2010-2012
Carnegie Institution for Science, Washington, DC

Education

Doctor of Philosophy in Geoscience, May 2010
The Pennsylvania State University, University Park, PA
Thesis: *Mechanisms of Aqueous Crystallization and Phase Transformation in Titanium Oxide Minerals*

Bachelor of Science in Geology, with Distinction, May 2004
Iowa State University of Science and Technology, Ames, IA
Minors: Physics, Mathematics, Spanish

Bachelor of Science in Chemistry, with Distinction, May 2004
Iowa State University of Science and Technology, Ames, IA

Peer-Reviewed Scientific Publications

Moore, EK; Ostroverkhova, A; **Hummer, DR**; Morrison, SM; Spielman, SJ. (2022)
The influence of oxygen and electronegativity on iron mineral chemistry throughout Earth's history. *Precambrian Research*, in review.

Williams, JR; Potter-McIntyre, SL; Morrison, SM; **Hummer, DR**; Filiberto, J. (2022) Using machine learning approaches to document the evolution of tourmaline-bearing localities in the United States. *Earth System Science Data*, in review.

Hummer, DR; Manning, CE; Kavner, A; Kono, Y; Park, C; Kenney-Benson, C. (2022) Structure of carbonated silicate liquids at upper mantle conditions using X-ray diffuse scattering. *Nature Geoscience*, in final preparation.

Hummer, DR. (2022) Ionic moduli: A new semi-empirical model for the compression of crystalline ionic compounds. *Journal of Physical Chemistry C*, in review.

Hummer, DR; Golden, JJ; Hystad, G; Liu, C; Downs, RT. Hazen, RM. (2022) Evidence for the oxidation of Earth's crust from the evolution of manganese minerals. *Nature Communications* 13:960, <https://doi.org/10.1038/s41467-022-28589-x>.

Hummer, DR. (2021) Fractal distribution of mineral species among the crystallographic point groups. *American Mineralogist* 106, 1574-1579.

Prabhu, A; Morrison, SM; Eleish, A; Zhong, H; Huang, F; Golden, JJ; Perry, SN; **Hummer, DR**; Ralph, J; Runyon, SE; Fontaine, K; Krivovichev, S; Downs, RT; Haze, RM; Fox, P. (2020) Global Earth mineral inventory: A data legacy. *Geoscience Data Journal* 8, 74-89.

Morrison, SM; Buongiorno, J; Downs, RT; Eleish, A; Fox, P; Giovannelli, D; Golden, JJ; **Hummer, DR**; Hystad, G; Kellogg, LH; Kreylos, O; Krivovichev, SV; Liu, C; Meredith, A; Prabhu, A; Ralph, J; Runyon, SE; Zahirovic, S; Hazen, RM. (2020) Exploring carbon mineral systems: Recent advances in C mineral evolution, mineral ecology, and network analysis. *Frontiers in Earth Science* 8:208, doi: 10.3389/feart.2020.00208.

Hazen, RM; Bromberg, Y; Downs, RT; Eleish, A; Falkowski, PG; Fox, P; Giovannelli, D; **Hummer, DR**; Hystad, G; Golden, JJ; Knoll, AH; Li, CR; Liu, C; Moore, EK; Morrison, SM; Muscente, AD; Ralph, J; Rucker, MY; Warden, LA; Zhong, H. (2020) *Deep Carbon Through Deep Time Data-Driven Insights* in "Deep Carbon Past to Present" eds. Orcutt, BN; Daniel, I; Dasgupta, R. Cambridge University Press, Cambridge, England.

Costello, LJ; Filiberto, J; Crandall, JR; Potter-McIntyre, SL; Schwenzer, SP; Miller, MA; **Hummer, DR**; Olsson-Francis, K; Perl, S. (2020) Habitability of hydrothermal systems at Jezero and Gusev Craters as constrained by hydrothermal alteration of a terrestrial mafic dike. *Geochemistry* 80, 125613.

- Hazen, RM; Downs, RT; Eleish, A; Fox, P; Gagné, OC; Golden, JJ; Grew, ES; **Hummer, DR**; Hystad, G; Krivovichev, SV; Li, C; Liu, C; Ma, X; Morrison, SM; Pan, F; Pires, AJ; Prabhu, A; Ralph, J; Runyon, SE; Zhong, H. (2019) Data-driven discovery in mineralogy: Recent advances in data resources, analysis, and visualization, *Engineering* 5, 397-405.
- Barry, PH; de Moor, JM, Giovannelli, D; Schrenk, M; **Hummer, DR**; Lopez, T; Pratt, CA; Alpizar Segura, Y; Battaglia, A; Beaudry, P; Bini, G; Cascante, M; d'Errico, G; di Carlo, M; Fattorini, D; Fullerton, K; Gazel, E; Gonzalez, G; Halldorsson, SA; Iacovino, K; Kulongoski, JT; Manini, E; Martinez, M; Miller, H; Nagawa, M; Ono, S; Patwardhan, S; Ramirez, CJ; Regoli, F; Smedile, F; Turner, S; Vetriani, C; Yucel, M; Ballentine, CJ; Fischer, TP; Hilton, DR; Lloyd, KG. (2019) Forearc carbon sequestration reduces long-term volatile recycling into the mantle. *Nature* 568, 487-492.
- Knafelc, J; Filiberto, J; Ferre, EC; Conder, JA; Costello, L; Dyar, MD; Friedman, SA; **Hummer, DR**; Schwenzer, SP; Walsh, KB. (2019) The effect of oxidation on the mineralogy and magnetic properties of olivine. *American Mineralogist* 104, 694-702.
- Liu, C; Eleish, A; Hystad, G; Golden, JJ; Downs, RT; Morrison, SM; **Hummer, DR**; Ralph, JP; Fox, P; Hazen, RM. (2018) Analysis and visualization of vanadium mineral diversity and distribution. *American Mineralogist* 103, 1080-1086.
- Ma, X; **Hummer, DR**; Golden, JJ; Fox, PA; Hazen, RM; Morrison, SM; Downs, RT; Madhikarmi, BL; Wang, C; Meyer, MB. (2017) Using visual exploratory data analysis to facilitate collaboration and hypothesis generation in cross-disciplinary research. *International Journal of Geoinformation* 6, 368.
- Bower, DM; Steele, A; **Hummer, DR**. (2017) The taphonomy of cyanobacterial mats in siliciclastic sediments: implications for life detection strategies. *Palaios* 32, 725-738.
- Morrison, SM; Liu, C; Eleish, A; Prabhu, A; Li, C; Ralph, J; Downs, RT; Golden, JJ; Fox, P; **Hummer, DR**; Meyer, MB; Hazen, RM. (2017) Network analysis of mineralogical systems. *American Mineralogist* 102, 1588-1596.
- Hummer, DR**; Noll, B; Hazen, RM; Downs, RT. (2017) Crystal structure of abelsonite, the only known crystalline geoporphyrin. *American Mineralogist* 102, 1129-1132.
- Kampf, AR; Cooper, MA; Nash, BP; Cerling, CE; Marty, J; **Hummer, DR**; Celestian, AJ; Rose, TP; Trebisky, TJ. (2017) Rowleyite, $[\text{Na}(\text{NH}_4, \text{K})_9\text{Cl}_4][\text{V}^{5+,4+}_2(\text{P}, \text{As})\text{O}_8]_6 \cdot n[\text{H}_2\text{O}, \text{Na}, \text{NH}_4, \text{K}, \text{Cl}]$, a new mineral with a microporous framework structure. *American Mineralogist* 102, 1037-1044.

- Liu, C; Hystad, G; Golden, JJ; **Hummer, DR**; Downs, RT; Morrison, SM; Ralph, J; Hazen, RM. (2017) Chromium mineral ecology. *American Mineralogist* 102, 612-619.
- Hazen, RM; Hystad, G; Golden, JJ; **Hummer, DR**; Liu, C; Downs, RT; Morrison, SM; Grew, ES. (2017) Cobalt mineral ecology. *American Mineralogist* 102, 108-116.
- Hazen, R; **Hummer, DR**; Hystad, G; Downs, R; Golden, JJ. (2016) Carbon mineral ecology: predicting the undiscovered minerals of carbon. *American Mineralogist* 101, 889-906.
- Bower, DM; **Hummer, DR**; Steele, A; Kyono, A. (2015) The co-evolution of Fe-oxides, Ti-oxides, and other microbially induced mineral precipitates in sandy sediments: Understanding the role of cyanobacteria in weathering and early diagenesis. *Journal of Sedimentary Research* 85, 1213-1227.
- Hummer, DR**; Heaney, PJ. (2015) MinKin: A kinetic modeling program for the precipitation, dissolution, and phase transformation of minerals in aqueous solution. *Chemical Geology* 405, 112-122.
- Kono, Y; Kenney-Benson, C; **Hummer, DR**; Ohfuji, H; Park, C; Shen, G; Wang, Y; Kavner, A; Manning, CE. (2014) Ultralow viscosity of carbonate melts at high pressures. *Nature Communications* 5:5091 doi: 10.1038/ncomms6091.
- Hummer, DR**; Kubicki, JD; Kent, PRC; Heaney, PJ. (2013) Single-site and monolayer surface hydration energy of anatase and rutile nanoparticles using density functional theory. *Journal of Physical Chemistry C* 117, 26084-26090.
- Seagle, CT; Cottrell, E; Fei, Y; **Hummer, DR**; Prakapenka, VB. (2013) Electrical and thermal transport properties of iron and iron-silicon alloy at high pressure. *Geophysical Research Letters* 40, 5377-5381.
- Lee, N; **Hummer, DR**; Sverjinsky, DA; Rajh, T; Hazen, RM; Steele, A; Cody, GD. (2012) Speciation of L-DOPA on nanorutile as a function of pH and surface coverage using surface-enhanced Raman spectroscopy (SERS). *Langmuir* 28(50), 17322-17330.
- Hummer, DR**; Heaney, PJ; Post, JE. (2012) In situ observations of particle size evolution during hydrothermal crystallization of TiO₂: A time-resolved synchrotron SAXS and WAXS study. *Journal of Crystal Growth* 344(1), 51-58.
- Hummer, DR**; Fei, Y. (2012) Synthesis and crystal chemistry of Fe³⁺-bearing (Mg,Fe³⁺)(Si,Fe³⁺)O₃ perovskite. *American Mineralogist* 97, 1915-1921.

Hummer, DR; Kubicki, JD; Kent, PRC; Post, JE; Heaney, PJ. (2009) The origin of nanoscale stability reversals in titanium oxide polymorphs. *Journal of Physical Chemistry C* 113(11), 4240-4245.

Heaney, PJ; Post, JE; Fischer, TB; **Hummer, DR;** Lopano, CL; Wall, AJ. (2008) Applications of time-resolved synchrotron X-ray diffraction to cation exchange, crystal growth and biomineralization reactions. *Mineralogical Magazine* 72(1), 179-184.

Hummer, DR; Heaney, PJ; Post, JE. (2007) Thermal expansion of anatase and rutile between 300 and 575 K using synchrotron powder X-ray diffraction. *Powder Diffraction* 22(4), 352-357.

Proposals

Hummer, DR. (2022) Aqueous crystallization mechanisms of aluminum oxyhydroxide minerals. *National Science Foundation*, Division of Earth Sciences (\$376,529), submitted.

Hummer, DR; Rooney, TO. (2022) A new mechanism for the formation of rare earth element deposits in igneous systems. *National Science Foundation*, Division of Earth Sciences (~\$200,000), in final preparation.

Hummer, DR. (2021) CAREER: Crystallization mechanisms of Si and Al oxide minerals. *National Science Foundation*, Division of Earth Sciences (\$616,421), not funded.

Hummer, DR. (2020) Deciphering new modes of biomineralization from a novel phylum bacteria. *SIU Foundation* (\$10,000), not funded.

Hummer, DR. (2020) CAREER: Crystallization mechanisms of Si and Al oxide minerals. *National Science Foundation*, Division of Earth Sciences (\$619,761), not funded.

Geisler, M; Schoof, J; Huang, X; Samadi, Y; Geisler-Lee, J; Reeves, T; Hamilton-Brehm, S; Li, R; **Hummer, DR;** Rekabdar, B. (2019) Building the big data workforce to understand changing global environment. *National Science Foundation*, Research Traineeship (~\$3,000,000), not funded.

Hummer, DR. (2015) The carbon mineral challenge. *Sloan Foundation*, Deep Carbon Observatory (\$67,500), funded.

Barry, P; de Moor, JM; Giovannelli, D; **Hummer, DR;** Lloyd, K; Lopez, T; Pratt, K. (2015) Biology meets subduction: A collaborative and multi-disciplinary deep carbon field initiative. *Sloan Foundation*, Deep Carbon Observatory (\$464,129), funded.

Other Publications

Hummer, DR. (2019) *Book Review: An Introduction to X-ray Physics, Optics, and Applications* by Carolyn MacDonald. (2017) *American Mineralogist* (**invited**) 104, 914.

Hummer, DR. (2019) The Carbon Mineral Challenge: A worldwide effort to find Earth's missing carbon minerals. *Australian Journal of Mineralogy* (**invited**) 20, 55-63.

Hummer, DR. (2016) What the heck is a diamond anvil cell? *DCOECS15 Open Science Blog* [posted 2016 Mar 23]. <https://dcoecs15.wordpress.com/2016/03/23/what-the-heck-is-a-diamond-anvil-cell/>.

Eiblum, D; Lee, EC; Forman, M; Abendroth, E; Celino, A; Chu, M; DeFonce, E; **Hummer, DR**; Kosh, A; Rho, R; Wang, H; Zheng, D. (2013) *SAT Math Prep 800: Challenge Yourself to a Perfect Score*. CreateSpace Independent Publishing Platform. ISBN-10: 1490444807

Hummer, DR. Review of *Fabric of the Cosmos*, by Brian Greene. (2009) *Science* 324, 1268.

Research Experience

Assistant Professor, Department of Geology

Southern Illinois University, Carbondale, IL 2016-present

- Working on projects involving composition and evolution of minerals across geologic time, crystal chemistry of minerals at variable P-T conditions, and modeling interactions between minerals and fluids

Postdoctoral Scholar, Geophysical Laboratory

Carnegie Institution of Washington, Washington, DC 2015-2016

- Worked with Dr. Robert Hazen on the evolution of redox sensitive minerals
- Worked with Dr. Robert Hazen on the ecology of carbon-bearing minerals

Postdoctoral Scholar, Department of Earth, Planetary and Space Sciences

University of California, Los Angeles, CA 2012-2015

- Worked with Dr. Craig Manning and Dr. Abby Kavner on the local atomic structure and behavior of carbonate-silicate melts
- Worked with Dr. Craig Manning on solubility of carbonate minerals at high pressure and temperature

Postdoctoral Fellow, Geophysical Laboratory

Carnegie Institution of Washington, Washington, DC 2010-2012

- Worked with Dr. Yingwei Fei on the crystal chemistry of Fe³⁺-bearing bridgmanite and implications for lower mantle structure
- Worked with Dr. Namhey Lee, Dr. Dimitri Sverjinsky, Dr. George Cody, and Dr. Robert Hazen on amino acid adsorption on the surface of TiO₂ nanoparticles

- Worked with Dr. Dina Bower and Dr. Andrew Steele to examine mineral biosignatures in Archean rocks using Raman spectroscopy
- Worked independently on a theoretical model quantifying the compression of ionic materials as a function of the compression of their individual ions

Research Assistant, Department of Geoscience

The Pennsylvania State University, University Park, PA 2004-2010

- Worked with Dr. Peter Heaney and Dr. James Kubicki on the crystallization of titanium oxides from hydrothermal solutions using time-resolved synchrotron X-ray diffraction, quantum calculations, and small angle X-ray scattering

Research Assistant, Department of Chemistry

Iowa State University, Ames, IA 2003

- Investigated the crystal chemistry of a Gd-(Sn,Si) solid solution series using single crystal and powder X-ray diffraction

Research Assistant, Department of Geological and Atmospheric Sciences

Iowa State University, Ames, IA 2003-2004

- Assisted in solution design and preparation for a road degradation study in collaboration with the Iowa Department of Transportation
- Investigated fractal geometry of carbonate tidal streams on Andros Island, Bahamas

Research Assistant, Ames Laboratories

Ames, IA 1999-2000

- Designed automated dry chemical Hg analysis method for industrial flue gases

Teaching Experience

Assistant Professor, Dept. of Geology/School of Earth Systems and Sustainability

Southern Illinois University, Carbondale, IL 2016-present

- **GEOL 310:** Mineralogy (for undergrad geology majors)
- **GEOL 419:** Ore Deposits (for undergrad geology majors and graduate students)
- **GEOL 464:** Earth's Deep Interior (for undergrad geology majors and graduate students)
- **GEOL 518:** Clay Mineralogy (for graduate students)
- **SCI 210A and 210B:** Integrated Science (for elementary education majors)
- **GEOL 128/129:** The Dinosaurian World (for undergrad non-majors)

Tutor, TutorPro Co.

Washington, DC 2010-2012

- Tutored high school and college students in chemistry, physics, algebra, geometry, and calculus

Teaching Assistant, Department of Geoscience

The Pennsylvania State University, University Park, PA 2004, 2008

- Assisted in teaching environmental geology for non-majors
- Taught introductory geology lab for non-majors

Teaching Assistant, Department of Chemistry

Iowa State University, Ames, IA 2000-2004

- Taught general chemistry recitations for chemistry and biochemistry majors, as well as non-majors
- Prepared, taught and supervised 3 hour general chemistry laboratory classes for chemistry and biochemistry majors, as well as non-majors
- Served as substitute lecturer for general chemistry large lecture courses

Teaching Assistant, Department of Geological and Atmospheric Sciences

Iowa State University, Ames, IA 2002-2004

- Taught 2 hour introductory geology lab class for non-majors
- Taught and supervised optical petrology laboratory class for geology majors

Tutor, Health Careers Opportunity Program

Des Moines Area Community College, Ankeny, IA 2002

- Tutored underprivileged Des Moines area high school students in biology, chemistry, and math during a summer program

Other Work and Leadership Experience

Museum Exhibit Designer, American Museum of Natural History 2019-2021

- Leading a team of AMNH personnel and other contractors to design a mineral evolution exhibit for the American Museum of Natural History, New York City.

Organizing Committee Member, Outstanding Student Presentation Award (OSPA) Committee, American Geophysical Union 2017-present

- Involved in organizing judges, scheduling, judging, scoring, and selection for the OSPA program at the annual AGU Fall Meeting.

Organizing Committee Member, DCO Field Focus Site 2016-present

- Collaborating with a team of early career researchers within the Deep Carbon Observatory to propose, design, and implement a cross-disciplinary field sampling campaign to characterize the flux of carbon-bearing species and other volatiles through an active subduction zone.

Principal Investigator, The Carbon Mineral Challenge 2015-2019

- Leading a worldwide effort with mineralogists and collectors to discover new carbon-bearing minerals

Organizing Committee Member, Second DCO Early Career Workshop 2014-2015

- Worked with 6 other committee members to arrange logistics, create budget, attract corporate sponsors, review participant applications, and organize scientific program for the Second Early Career Scientist Workshop of the Deep Carbon Observatory at the University of the Azores, Ponta Delgada, Azores, Portugal, Aug. 31-Sept. 5, 2015.

Associate Editor, American Mineralogist

2012-present

- Handling editing and peer review for general submissions
- Handled editing and peer review for the special section *Chemistry and Mineralogy of Earth's Mantle* with co-AE Katherine Crispin

Professional Affiliations

- Mineralogical Society of America
- Geological Society of America
- American Geophysical Union
- American Chemical Society
- European Association of Geochemistry
- American Association for the Advancement of Science

Conference Presentations and Seminars

Hummer, DR. Data mining the past: Using large mineral datasets to trace Earth's geochemical history. *ENIGMA Annual Meeting (invited)*, Rutgers University, May 2022.

Hummer, DR. Data mining the past: Using large mineral datasets to trace Earth's geochemical history. *Harrisburg Area Geol. Society Seminar (invited)*, Oct. 2021.

Hummer, DR. Pretty colors: How minerals and gemstones get their colors (and other unusual properties). *SIU Geology Club Seminar (invited)*, Sep. 2021.

Hummer, DR. Data mining the past: Using large mineral datasets to trace Earth's geochemical history. *Southern Illinois Earth Science Club Seminar (invited)*, Aug. 2021.

Moore, EK; Ostroverkhova, A; **Hummer, DR**; Morrison, SM; Spielman, SJ. Investigating iron redox evolution using the mineral chemistry network analysis platform, dragon. *Goldschmidt Programs and Abstracts*, session 10e, Jul. 2021.

Hummer, DR. Symmetry in nature: Groups, fractals, and more. *SIU Physics Department Seminar (invited)*, Feb. 2021.

- Hummer, DR;** Ma, X; Que, X; Zhang, S; Liu, C; Hazen, RH; Golden, JJ; Downs, RT. (2020) Towards quantitative scales of lithophilicity, chalcophilicity and hydrophilicity using statistical correlations among the mineral-forming elements. *Goldschmidt Programs and Abstracts*, session 6h, Jun. 2020.
- Morrison, SM; Eleish, A; Prabhu, A; Narkar, S; Pan, F; Huang, F; Fox, PA; Hystad, G; Liu, C; Buongiorno, J; Zhang, S; Ma, X; Ralph, J; Krivovichev, SV; Giovannelli; Runyon, SE; **Hummer, DR;** Golden, JJ; Downs, RT; Hazen, RM. (2019) Exploring carbon mineralogy and mineral evolution through deep time with advanced analytics and visualization. *AGU Programs and Abstracts*, session DI43A, Dec. 2019.
- Prabhu, A; Morrison, SM; Eleish, A; Zhong, H; Huang, F; Golden, JJ; Perry, S; **Hummer, DR;** Ralph, J; Runyon, SE; Fontaine, KS; Krivovichev, SV; Downs, RT; Hazen, RM; Fox, PA. (2019) Creating, managing and evaluating data legacies: Updates on the Global Earth Mineral Inventory. *AGU Programs and Abstracts (invited)*, session U11C, Dec. 2019.
- Zhong, H; Prabhu, A; Huang, F; Eleish, A; Chastain, K; Thomson, BL; Narkar, S; Fontaine, KS; **Hummer, DR;** Morrison, SM; Downs, RT; Hazen, RM; Fox, PA; Heaney, PJ. (2019) Interactive, web-based visualizations for hierarchical information and knowledge in geosciences: An implementation on the Dana classification and its applications. *AGU Programs and Abstracts*, session IN21B, Dec. 2019.
- Hummer, DR.** (2019) The Carbon Mineral Challenge: A look back at a four year experiment in big data mineralogy. *Deep Carbon Observatory International Science Meeting (invited)*, Oct. 2019.
- Hummer, DR.** (2019) Data mining the past: Using large mineral databases to trace Earth's geochemical history. *Penn State University Geoscience Seminar (invited)*, Oct. 2019.
- Hummer, DR;** Wood, J; Pratt, CA; Trew-Crist, D; Downs, RT; Golden, JJ; Hystad, G; Hazen, RM. (2019) The Carbon Mineral Challenge: A look back on a four-year experiment in big data mineralogy. *Geological Society of America Programs and Abstracts*, session D14, Sep. 2019.
- Barry, PH; de Moor, JM; Giovannelli, D; Schrenk, M; **Hummer, DR;** Lopez, T; Pratt, CA; Lloyd, KG. (2019) Calcite precipitation in the Costa Rican forearc reduces long term carbon recycling into the Earth's deep mantle. *Goldschmidt Programs and Abstracts*, session 3k, Aug. 2019.
- Hummer, DR.** (2018) Ionic moduli: A new semi-empirical model describing the compression and phase transitions of crystalline ionic solids. *AGU Programs and Abstracts*, session DI31C, Dec. 2018.

- de Moor, MJ; Barry, PH; Lloyd, KG; Giovannelli, D; Schrenk, M; Nakagawa, M; Ramirez, CJ; Pratt, CA; Hummer, DR; Lopez, TM. (2018) Chemical and biological carbon sinks in the Costa Rican forearc: First insights from the Biology Meets Subduction project. *AGU Programs and Abstracts*, session DI31A, Dec. 2018.
- Prabhu, A; Morrison, SM; Eleish, A; Zhong, H; Huang, F; Fontaine, KS; Parsons, MA; Fox, PA; **Hummer, DR**; Perry, S; Hazen, RM. (2018) Global Earth mineral inventory: A DCO legacy. *AGU Programs and Abstracts*, session IN53E, Dec. 2018.
- Hummer, DR**; Hazen, RM; Eleish, A; Liu, C; Morrison, SM; Downs, RT; Golden, JJ; Pires, A; Hystad, G; Meyer, M. (2018) Ecology and evolution of manganese minerals: Implications for the redox history of Earth and life. *Geological Society of America Programs and Abstracts*, session T115, Nov. 2018.
- Wilson, KR; **Hummer, DR**; Denny, FB; Filiberto, J. (2018) Mode of mineralization and relationship with igneous intrusions of rare earth elements at Hicks Dome, Illinois. *Geological Society of America Programs and Abstracts*, session T32, Nov. 2018.
- Hummer, DR**. (2018) Data mining the past: Using large mineral datasets to trace Earth's geochemical history. *Southern Illinois University, Geology Department Seminar*, Sep. 2018.
- Hummer, DR**; Golden, JJ; Hystad, G; Downs, RT; Eleish, A; Liu, C; Ralph, J; Morrison, SM; Meyer, MB; Hazen, RM. (2017) Timing the oxidation of Earth's crust: Evidence from big data records of manganese mineralization. *AGU Programs and Abstracts*, session V24C, Dec. 2017.
- Hummer, DR**; Hazen, RM; Eleish, A; Liu, C; Morrison, SM; Downs, RT; Golden, JJ; Pires, A; Hystad, G; Meyer, MB. (2017) Ecology and evolution of manganese minerals: Implications for the redox history of Earth and life. *Goldschmidt Programs and Abstracts*, session 14a, Aug. 2017.
- Hazen, RM; Eleish, A; Liu, C; Morrison, SM; Meyer, MB; Fox, P; **Hummer, DR**; Downs, RT; Golden, JJ; Pires, A; Hystad, G; Ralph, J. (2017) Carbon mineral network analysis: A big data geobiology study. *Goldschmidt Programs and Abstracts*, session 14a, Aug. 2017.
- Morrison, SM; Eleish, A; Liu, C; **Hummer, DR**; Giovannelli, D; Meyer, MB; Fox, P; Downs, RT; Golden, JJ; Pires, A; Hystad, G; Ralph, J; Hazen, RM. (2017) Network Analysis Applications: Exploring Geosphere and Biosphere Co-evolution with Big Data Techniques. *Goldschmidt Programs and Abstracts*, session 14a, Aug. 2017.

- Hummer, DR.** (2017) Mineral ecology and evolution: Using large datasets to tell the story of the co-evolution of Earth and life. *Arizona Geological Society (invited)*, Feb. 2017.
- Hummer, DR.** (2017) The Carbon Mineral Challenge: A first of its kind worldwide search for new mineral species. *Arizona Geological Society (invited)*, Feb. 2017.
- Hummer, DR.** (2016) Ionic moduli: A new semi-empirical model for the compression of crystalline materials. *AGU Programs and Abstracts*, session MR23A, Dec. 2016.
- Morrison, SM; Downs, RT; Golden, JJ; Pires, A; Fox, PA; Ma, X; Zednik, S; Eleish, A; Prabhu, A; **Hummer, DR**; Liu, C; Meyer, M; Ralph, J; Hystad, G; Hazen, RM. (2016) Exploiting mineral data: applications to the diversity, distribution, and social networks of copper minerals. *AGU Programs and Abstracts*, session IN41A, Dec. 2016.
- Giovannelli, D; Cox, AD; **Hummer, DR**; Pratt, K; Sheik, C; Thomas, D; Viveiros, FM. (2016) Multidisciplinary field surveys as the new norm: Integrating geosciences to characterize the fate of carbon in a geothermal fumarole. *AGU Programs and Abstracts*, session B13G, Dec. 2016.
- Hummer, DR**; Hazen, RM; Ma, X; Golden, JJ; Downs, RT; Liu, C; Morrison, SM; Meyer, M. (2016) Quantifying and visualizing Earth's mineral chemistry through geologic time. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.
- Liu, C; Hazen, RM; Hystad, G; Golden, JJ; **Hummer, DR**; Downs, RT, Morrison, SM; Ralph, J. (2016) Chromium and vanadium mineral ecology. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.
- Ma, X; **Hummer, DR**; Hazen, RM; Golden, JJ; Fox, P; Meyer, M. (2016) Showing correlations between elements and minerals in a three-dimensional matrix. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.
- Meyer, M; Downs, RT; Falkowski, PG; Fox, P; Hazen, RM; Knoll, AH; Sverjensky, DA; Golden, JJ; Hao, J; Hystad, G; **Hummer, DR**; Jelen, B; Kolankowski, S; Liu, C; Ma, X; Moore, EK; Morrison, SM; Muscentie, AD; Pires, AJ; Zednick, S; Zhong, H. (2016) The co-evolution of the geo- and biospheres: An integrated program for data-driven, abductive discovery in the Earth sciences. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.
- Morrison, SM; Downs, RT; Golden, JJ; Pires, AJ; Fox, P; Ma, X; Zednick, S; Eleish, A; Kolankowski, S; Liu, C; **Hummer, DR**; Meyer, M; Ralph, J; Hystad, G; Hazen, RM. (2016) Mineral ecology: Social network analysis and sociograms of mineral connections, distributions, and segmentation. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.

- Morrison, SM; Downs, RT; Golden, JJ; Pires, AJ; Fox, P; Ma, X; Zednick, S; Eleish, A; Kolankowski, S; **Hummer, DR**; Liu, C; Meyer, M; Ralph, J; Hystad, G; Hazen, RM. (2016) Social network of copper minerals: A mineral ecology study. *Geological Society of America Programs and Abstracts*, session T129, Sep. 2016.
- Hummer, DR**; Hazen, RM; Ma, X; Golden, JJ; Downs, RT. (2016) Constraints on the mineral evolution of planetary crusts using statistical correlations and anti-correlations among the mineral-forming elements. *Goldschmidt Programs and Abstracts*, session 6f, June 2016.
- Hazen, RM; **Hummer, DR**; Liu, C; Hystad, G; Downs, RT; Golden, JJ; Morrison, SM. (2016) Mineral ecology and evolution of first-row transition elements. *Goldschmidt Programs and Abstracts*, session 3g, June 2016.
- Hummer, DR**; Hazen, RM; LaFuente, B. (2015) The Carbon Mineral Challenge: A worldwide hunt for new carbon minerals. *Press Workshop, American Geophysical Union*, Dec. 2015.
- Hummer, DR**; Manning, CE; Kavner, A; Kono, Y; Park, C; Kenney-Benson, C. (2015) Structure and viscosity of carbonate-silicate melts using in situ techniques. *AGU Programs and Abstracts*, session V14C (**invited**), Dec. 2015.
- Hummer, DR**, Hazen, RM; Golden, J; Downs, RT. (2015) Constraints on the mineral evolution of terrestrial planets using statistical correlations among the mineral-forming elements. *AGU Programs and Abstracts*, session V51C, Dec. 2015.
- Hazen, RM; **Hummer, DR**; Downs, RT; Hystad, G; Golden, J. (2015) Carbon mineral ecology: Predicting the undiscovered minerals of carbon. *AGU Programs and Abstracts*, session V51C, Dec. 2015.
- Hummer, DR**; Hazen, RM; Hystad, G; Golden, J; Downs, RT. (2015) Mineral ecology and evolution of manganese: Using redox sensitive minerals to probe Earth's history. *Geological Society of America Programs and Abstracts*, session T133, Nov. 2015.
- Hummer, DR**; Manning, CE; Kavner, A; Kono, Y; Park, C; Kenney-Benson, C. (2015) Viscosity of carbonate-silicate melts using ultra-high resolution falling sphere viscometry. *Second Early Career Scientist Workshop, Deep Carbon Observatory*, Sep. 2015.
- Hummer, DR**; Heaney, PJ. (2015) MinKin: A new computational tool for modeling the kinetics of multi-component geochemical systems. *Goldschmidt Programs and Abstracts*, session 14d, Aug. 2015.

- Giovannelli, D; Cox, A; **Hummer, DR**; Pratt, K; Sheik, C; Thomas, D; Viveiros, F. (2015) Second DCO Early Career Workshop. *Deep Carbon Observatory Second International Science Meeting*, Mar. 2015.
- Hummer, DR**; Manning, CE; Kavner, A; Kono, Y; Park, C; Kenney-Benson, C. (2015) Viscosity of carbonate-silicate melts using ultra-high resolution falling sphere viscometry. *Deep Carbon Observatory Second International Science Meeting*, Mar. 2015.
- Hummer, DR**; Kavner, A, Manning, CE; Kono, Y; Park, C; Kenney-Benson, C. (2014) Viscosity of carbonate-silicate melts using ultra-high resolution falling sphere viscometry. *AGU Programs and Abstracts*, session DI-13A, Dec. 2014.
- Hummer, DR**; Manning, CE; Kavner, A; Park, C; Kono, Y; Kenney-Benson, C. (2014) Structure and viscosity of carbonate-silicate melts using in situ X-ray scattering. *Extreme Physics and Chemistry Workshop, Deep Carbon Observatory, UCLA (invited)*, Oct. 2014.
- Hummer, DR.** (2014) Ionic moduli: A new semi-empirical model describing the compression of crystalline ionic compounds. *Goldschmidt Programs and Abstracts*, session 26a, June 2014.
- Hummer, DR**; Kavner, A; Manning, CE; Park, C; Kono, Y; Kenney-Benson, C. (2014) The effect of composition and pressure on the structure of carbonate-silicate melts using in situ X-ray diffuse scattering. *Goldschmidt Programs and Abstracts*, session 4a **(invited)**, June 2014.
- Hummer, DR**; Kavner, A; Manning, CE. (2014) The effect of composition and pressure on the structure of carbonate-silicate melts using in situ X-ray diffuse scattering. *Early Career Scientists Workshop, Deep Carbon Observatory, San Jose, Costa Rica (invited)*, Feb. 2014.
- Hummer, DR**; Kavner, A; Manning, CE. (2013) The effect of composition and pressure on the structure of carbonate-silicate melts using in situ X-ray diffuse scattering. *AGU Programs and Abstracts*, session MR-32A, Dec 2013.
- Hummer, DR**; Kavner, A; Manning, CE. (2013) Structure of carbonate-silicate melts at high P-T conditions using in situ X-ray diffuse scattering. *Goldschmidt Programs and Abstracts*, session 21b, Aug 2013.
- Bower, D; **Hummer, DR**; Kyono, A; Steele, A; Armstrong, J. (2013) The co-evolution of Fe-, Ti-oxides and other microbially induced mineral precipitates during the diagenesis of sandy sediments. *Goldschmidt Programs and Abstracts*, session 9e, Aug 2013.

- Kubicki, J; Sung-Yup, K; van Duin, A; Ridley, M; Machesky, M; **Hummer, DR**; Kent, PRC. (2013) Modeling of TiO₂ nanoparticles interactions with water and ions. *Goldschmidt Programs and Abstracts*, session 10e, Aug 2013.
- Hummer, DR**; Kavner, A; Manning, CE. (2013) Structure of carbonate-silicate melts at high P-T conditions using in situ X-ray diffuse scattering. *COMPRES Annual Meeting*, Jun 2013.
- Hummer, DR**; Kavner, A; Manning, CE. (2013) Structure of carbonate-silicate melts at high P-T conditions using in situ X-ray diffuse scattering. *Paris Edinburgh Cell Workshop, Argonne National Laboratory*, May 2013.
- Hummer, DR**; Kavner, A; Manning, CE. (2013) Structure of carbonate-silicate melts at high P-T conditions using in situ X-ray diffuse scattering. *Gordon Research Conference: Interior of the Earth*, May 2013.
- Hummer, DR**. (2013) The surprising effects of ferric iron on MgSiO₃ perovskite in Earth's lower mantle. *Geology Club Seminar, California Institute of Technology*, (invited) Jan 2013.
- Hummer, DR**; Kavner, A; Manning, CE. (2012) Structure of CaCO₃-CaSiO₃ melts at high P-T conditions using in situ X-ray diffuse scattering in a Paris-Edinburgh press. *AGU Programs and Abstracts*, session V-53D, Dec 2012.
- Hummer, DR**; Fei, Y; Seagle, CT. (2011) Thermal equation of state of Fe(III) and Al-bearing magnesium silicate perovskite. *AGU Programs and Abstracts*, session MR-43A, Dec 2011.
- Bower, DM; **Hummer, DR**; Kyono, A; Steele, A; Armstrong, JT. (2011) The co-evolution of Fe,Ti-oxides and other microbially induced mineral precipitates in sandy sediments: Understanding the role of microbes in diagenesis. *AGU Programs and Abstracts*, session B-51I, Dec 2011.
- Seagle, CT; Cottrell, E; Fei, Y; **Hummer, DR**; Prakapenka, V. (2011) Electrical and thermal conductivity of iron and iron-silicon alloy at high pressures. *AGU Programs and Abstracts*, session MR54A, (invited) Dec 2011.
- Bower, DM; **Hummer, DR**; Kyono, A; Steele, A. (2011) The co-evolution of Fe-,Ti-oxides and microbial fossilization during early diagenesis in sandy sediments: establishing potential mineral biosignatures. *Geological Society of America Programs and Abstracts*, 129-5, Oct 2011.
- Hummer, DR**. (2011) From atoms to crystals: Tracking phase stability reversal in TiO₂ minerals at the onset of crystallization. *Geochemistry Seminar, University of Maryland*, (invited) Sep 2011.

- Hummer, DR;** Fei, Y. (2011) Crystal chemistry of Fe³⁺ in (Mg,Fe)SiO₃ perovskite and implications for lower mantle properties. *Goldschmidt Programs and Abstracts*, session 3f, Aug 2011.
- Hummer, DR;** Fei, Y. (2010) Crystal chemistry of Fe(III)-bearing magnesium silicate perovskite. *AGU Programs and Abstracts*, session MR-41B, Dec 2010.
- Hummer, DR;** Heaney, PJ; Post, JE. (2010) Probing the aqueous nucleation and growth of TiO₂ with high time-resolution small-angle and wide-angle X-ray scattering. *Goldschmidt Programs and Abstracts*, session 17c, June 2010.
- Hummer, DR;** Heaney, PJ; Kubicki, JD; Kent, PRC; Post, JE. (2008) Nanoscale phase stability reversal during the nucleation and growth of titanium oxide minerals. *AGU Programs and Abstracts*, session V-23F, Dec 2008.
- Hummer, DR;** Heaney, PJ; Kubicki, JD; Kent, PRC; Post, JE. (2008) The origin of nanoscale stability reversals in titanium oxide minerals. *Geological Society of America Abstracts with Programs*, session T93, Oct 2008.
- Hummer, DR;** Heaney, PJ; Kubicki, JD; Kent, PRC. (2008) Nanoscale stability reversal in titanium oxide polymorphs. *Center for Nanophase Materials Science User Conference, Oak Ridge National Laboratory, (invited)* Sep 2008.
- Hummer, DR;** Heaney, PJ; Post, JE; Kubicki, JD. (2007) Nucleation, growth, and phase transformation of titanium oxides in hydrothermal solution. *Goldschmidt Programs and Abstracts*, session S97, Aug 2007.
- Hummer, DR;** Heaney, PJ; Post, JE. (2006) Aqueous nucleation and growth of titanium oxides using time-resolved synchrotron X-ray diffraction. *AGU Joint Assembly Programs and Abstracts*, section V06, May 2006.

Conference Sessions Chaired

- Hummer, DR;** Farsang, S. (2022) Carbonates in deep Earth. *International Mineralogical Association General Meeting 2022, (invited)* oral session T2.
- Prabhu, A; Morrison, SM; Ma, X; **Hummer, DR.** (2022) Advances in mineral data resources and infrastructure. *International Mineralogical Association General Meeting 2022*, oral session T3.
- Hummer, DR;** Hystad, G. (2019) Recent advances in mineralogy/crystallography. *GSA Fall Meeting 2019*, oral session D14.

Morrison, SM; **Hummer, DR**; Bassez, MP; Holm, N; Remusat, L; Martins, Z. (2017) Exogenous organic compounds, minerals, prebiotic molecules and geobiotropy. *Goldschmidt Meeting 2017*, oral and poster session 14a.

Grew, ES; Ross, NL; **Hummer, DR**. (2016) Mineralogical evidence for the co-evolution of the geosphere and biosphere: In honor of Robert M. Hazen, 2016 Roebling medalist. *GSA Fall Meeting 2016*, oral and poster session T129.

Hummer, DR and Millot, M. (2014) Carbon chemistry in the deep Earth. *AGU Fall Meeting 2014*, poster session DI-13A.

Hummer, DR and Crispin, K. (2012) Impact of minor elements on lower mantle mineralogy I. *AGU Fall Meeting 2012*, oral session DI-23B.

Skills

- Thorough background in mineralogy, crystallography, petrology, aqueous chemistry, and solid state chemistry
- Experience with multi-anvil, piston cylinder, and diamond-anvil high pressure synthesis techniques
- Extensive experience with X-ray scattering techniques (especially XRD) and synchrotron work, including beamlines at NSLS, APS, and SSRL
- Experience with optical microscopy, electron microprobe, Raman and Mössbauer spectroscopy, SEM, TEM, SAXS, XRF, and ICP-MS
- Experience with field-based, hand sample, and mapping work
- Programming experience in Basic, Matlab, and Fortran
- Have worked at and collaborated with scientists at Pacific Northwest National Laboratory, Oak Ridge National Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Stanford Linear Accelerator Center, the Carnegie Institution for Science, and the Smithsonian Institution
- Experience doing multidisciplinary research with scientists from a variety of backgrounds through the DOE's Center for Environmental Kinetics Analysis, and the Deep Carbon Observatory
- Extensive teaching and tutoring experience in geoscience, chemistry, physics, and mathematics from the middle school to college levels
- Extensive public outreach experience including lectures, classroom demonstrations, hands-on activities, exhibitions, and mineral shows
- Semi-fluent in Spanish

Honors and Awards

- Mineral of the Year Award, International Mineralogical Association, Fall 2019 (retroactive for 2017)
- Emerging Leader Award, Deep Carbon Observatory, Fall 2017
- Carnegie Institution Postdoctoral Fellowship (\$100,000), Geophysical Laboratory, 2010-2012
- Muan Graduate Fellowship (\$3000), College of Earth and Mineral Sciences, Penn State University, Fall 2008
- Peter Deines lectureship, Dept. of Geoscience, Penn State University, Spring 2008
- Kraus Award for Crystallographic Research (\$5000), Mineralogical Society of America, Fall 2007
- Ohmoto Scholarship, Department of Geoscience, Penn State University, Fall 2006
- 2nd place, Physical Sciences and Mathematics division, Graduate poster exhibition, Penn State University, Spring 2005
- Excellence in Teaching Award, Iowa State University, Spring 2003
- Undergraduate academic achievement award, Department of Chemistry, Iowa State University, Spring 1999, 2000, 2001, 2002
- Outstanding undergraduate award, Department of Geological and Atmospheric Sciences, Iowa State University, Spring 2000, 2001, 2003
- Rodney G. Gardner Memorial Scholarship, Iowa State University, Spring 2002
- Levine Alumni Scholarship, Iowa State University, Spring 2002
- Golden Key Honor Society, Fall 2002
- Phi Beta Kappa, Spring 2001
- Peter Johnson Memorial Scholarship, Department of Geological and Atmospheric Sciences, Iowa State University, Spring 2001
- Top 2% of College of Liberal Arts and Sciences undergraduates, Iowa State University, Spring 1999, 2000
- Clifford C. Hach Memorial four-year scholarship (\$24,000), Department of Chemistry, Iowa State University, Spring 1999