

## CHEN ZHU

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### EDUCATION

Ph.D., The Johns Hopkins University, Aqueous Geochemistry, 1992  
M.Sc., University of Toronto, Economic Geology, 1987  
B.Eng., Chengdu Institute of Geology, Geology (with honors), 1982  
Post-doctoral Fellowship, Woods Hole Oceanographic Institution, 1991-92

### SELECTED HONORS AND AWARDS

2021-22, Henry Darcy Distinguished Lecturer, the Groundwater Foundation.  
2017, Fellow, American Association for the Advancement of Science.  
2016, Fellow, Mineralogical Society of America.  
2009, Fulbright Scholarship to Norway.  
2006, John Hem Award, National Ground Water Association.  
2005, Fellow, Geological Society of America.  
2003-04, Senior Associateship Award, National Research Council of the National Academies.  
1985-87, H. V. Ellsworth Prize in Mineralogy, University of Toronto.

### SELECTED VISITING PROFESSORSHIPS

2023-25 (part-time), Leverhulme Visiting Professor at the University of Cambridge, UK.  
2022, Visiting sabbatical professor, Swiss Federal Institute of Aquatic Science and Technology.  
2019, Professeur Invité, Toulouse Paul-Sabatier University/CNRS, France.  
2010, Guest Professorship, Okayama University, Japan.  
2008, Visiting sabbatical professor, University of California-Berkeley.  
2008, Guest Professorship, Swiss Federal Institute of Technology, Zurich, Switzerland.  
2004, Guest Professorship, Swiss Federal Institute of Technology, Zurich, Switzerland.

### PROFESSIONAL POSITIONS

2004-present, Indiana University, Haydn Murray Chair (10/2018-6/2021), Professor (7/2011-present),  
Associate Professor (1/2004-7/2011).  
2011-present, Adjunct Professor, School of Public and Environmental Affairs  
2013-present, Adjunct Professor of Environmental Health, School of Public Health, Bloomington, Indiana  
University  
2000-2003, Assistant Professor of Geology and Planetary Science, University of Pittsburgh.  
1998-2000, Assistant Professor of Ocean, Earth, and Atmospheric Sciences, Old Dominion Univ.  
1994-1998, Senior Geochemist, GeoTrans, Inc. (now part of TetraTech), Boulder, Colorado.  
1993, Senior chemist, OLI Systems, Morristown, New Jersey.

### RESEARCH INTERESTS

I study CO<sub>2</sub>-water-rock interactions, a ubiquitous Earth process that plays a pivotal role in our society's urgent efforts to combat climate change and adapt to its effects. While the core of my research has always been the kinetics, thermodynamics, and geochemical modeling of water-mineral reactions, my current research projects focus on three climate change-related themes:

**CO<sub>2</sub> Removal and Sequestration:** Removing CO<sub>2</sub> from the atmosphere and storing billions of tons of CO<sub>2</sub> in aquifers, minerals, and soils causes myriad CO<sub>2</sub>-water-rock interactions. My research aims to predict the consequences of these interactions in terms of CO<sub>2</sub> storage efficiency and safety. Click this link for our CCUS [publications](#). Our current projects focus on near-equilibrium reaction kinetics in multi-mineral systems and use non-traditional stable isotope doping as an innovative experimental technique. We investigate how reactions are coupled, e.g., how clay mineral precipitation can slow down basalt dissolution and compete for divalent metals for carbon sequestration.

**Critical Minerals:** The transition from fossil fuels to renewable and clean energy demands critical minerals, which were mostly formed as a result of water-rock interaction. Recently, my collaborators and I have embarked on a project on the thermodynamic and transport properties of rare earth elements to better inform the successful exploration of mineral resources.

**Climate Impact on Water Resources:** Warming climate impacts both water quantity and water quality. My studies of CO<sub>2</sub>-water-rock interactions inform both water availability and release mechanisms of contaminants to water. Recently, we have developed a regional-scale hydrological model that predicts a severe reduction of water availability in the historically water-rich Wabash River basin (USA) toward the end of the century (<https://FutureWater.indiana.edu>). Currently, we are developing models to assess the impact of climate change on water quality, using high-performance computers and machine learning tools.

## SELECTED SYNERGISTIC ACTIVITIES (LAST FIVE YEARS)

**Review panelist:** NSF, 2023, blue ribbon; 2021-22 (graduate fellowship), EAR, 2018; NASA, 2019.

**Editorship:** Co-executive editor, *Groundwater*, 6/22-present; Associate Editor, *Geochimica et Cosmochimica Acta*, 2005-2021.

**Tenure committees:** Indiana University, Bloomington campus, 2023-24; College of Arts and Science 2019-21.

**Award committees:** Kohout Early Career Award and Schwartz Award in the Hydro Div of Geological Society of America. Henry Darcy Distinguished Lectureship, the Groundwater Foundation, National Ground Water Association. Chair (2023-24), Owen Award committee, Department of Earth and Atmospheric Sciences, Indiana University.

**Lectureship:** Served as the 2021-2022 Henry Darcy Distinguished Lecturer, sponsored by the (US) Groundwater Foundation. Delivered 67 lectures (32 in-person in six countries) to universities, government agencies (NSF, EPA, USGS), national labs, and corporations. About 4500 people (including virtually) attended from 35 US states, six Canadian provinces, and 28 other countries. The keynote speech at the 2022 annual conference of the International Association of Hydrogeologists reportedly attracted ~8900 logged-on devices. [Weblink](#).

### **Science gateways, workshops, and short courses:**

- Developed the CyberPlatform <https://models.earth.indiana.edu/>, which hosts geochemical modeling software and thermodynamic and kinetic databases. These resources are extensively used by the geochemical community for research and teaching. The platform is available to all with no cost, reducing economic disparities and reaching out to the parts of the world where education and research resources are limited but environmental issues are more severe. Google Analytics recorded 7,400 users/visitors from 89 countries between September 2020 and September 2023.
- Taught pro bono short courses on “Advanced Geochemical Modeling” on three recent occasions. (1) July 3, 2021 (with Dr. Peng Lu) affiliated with the Goldschmidt conference (about 348 attendees from 44 countries participated). (2) On June 19, 2023, in the Department of Earth Science, the University of Cambridge, UK. (3) On August 17, 2023, in Sendai, Japan at the 17th Water-rock Workshop and 14th

Applied Isotope Geochemistry Conference, sponsored by the International Association of Geochemistry. About 60 attendees from many countries participated.

- Led a large team at Indiana University in the development of the Science Gateway <https://futurewater.indiana.edu/> for research, teaching, and service. The gateway hosts hydrologic models of the Wabash River basin. The water cycle is predicted to the year 2100 under two Representative Concentration Pathways (4.5 and 8.5) using climate data from an ensemble of 10 general circulation climate models. The models are run and stored on Indiana University's supercomputers. The outputs of the hydrological models are visualized with detailed maps and interactive graphs. Data are available for download, and "power users" can run their own models. To help K-12 schools cope with the pandemic, online teaching modules were developed and distributed to science teachers in Indiana in 2020. The gateway has attracted interest from state and federal agencies, utilities, NGOs, and municipalities in the historically water-rich Wabash River basin.
- Conducted a workshop "*Applications of isotope tracers to geochemical kinetics studies*" in the Department of Earth Science, University of Cambridge, UK, June 19, 2023. Organized and led a *pro bono* workshop (virtual), on June 21, 2020, "*Applications of isotope tracers to geochemical kinetics studies*" sponsored by the Geochemical Society. About 300 attendees from 34 countries participated. Lecture videos are available at <https://hydrogeochem.earth.indiana.edu/>.

## CURRENT RESEARCH GRANTS

National Science Foundation EAR 2242907, "Closing Critical Knowledge Gaps in Rates of CO<sub>2</sub> Mineralization in Soils, Rocks, and Aquifers as a Scalable Climate Change Mitigation Solution". PI: Chen Zhu; co-PI: Sudhakar Pamidighantam, 2023-2026. \$736,412.

Department of Energy, Basic Energy Science EAR DE-SC0022269, "Molecular complexation of rare earth elements (REE) in high temperature and pressure supercritical geologic fluids", PI: Alex Gysi (NMT); co-PI: Chen Zhu and five others, 2021-2024. \$2.7 million total, \$360,000 to Indiana University.

National Science Foundation EAR 2221907, "Collaborative Research: Probing zircon reactivity in aqueous solutions at solubility equilibrium using isotope tracers". PI: John Ayers (Vanderbilt); co-PI: Chen Zhu, 2022-2025, \$345,376 to Indiana University.

*I have been awarded, as PI, a total of \$4.2m of external, highly competitive research grants and \$0.9m of internal grants in my career.*

## PATENTS

U.S. Patent 7922792 issued on 12 April 2011 "Method for Sequestration of CO<sub>2</sub> and SO<sub>2</sub> Utilizing a Plurality of Waste Streams."

## SELECTED PUBLICATIONS

As of December 2023, I have published two books, 93 articles in peer-reviewed journals, three book chapters, and ten conference proceedings papers. [Click here for the complete list online.](#)

(<sup>U</sup>undergraduate, <sup>G</sup>graduate, <sup>PD</sup>postdoc authors supervised by Zhu; \*corresponding author)

**Zhu C** and Anderson GM (2002) *Environmental Applications of Geochemical Modeling*. Cambridge University Press, London, 304 pp. [weblink](#).

- <sup>G</sup>Kang JT, Bracco JN, Rimstidt JR, Zhu GH, Huang F, \*Zhu C (2022). Ba attachment and detachment fluxes to and from barite surfaces in <sup>137</sup>Ba-enriched solutions with variable [Ba<sup>2+</sup>]/[SO<sub>4</sub><sup>2-</sup>] ratios near solubility equilibrium. *Geochimica et Cosmochimica Acta*. v317, 180-200, [doi.org/10.1016/j.gca.2021.11.008](https://doi.org/10.1016/j.gca.2021.11.008).
- \*Zhu C, <sup>G</sup>Zhang YL, Rimstidt JD, Gong L, <sup>U</sup>Burkhart, JA, Chen KY, Yuan HL (2021) Testing hypotheses of albite dissolution mechanisms at near-equilibrium using Si isotope tracers. *Geochimica et Cosmochimica Acta*. v303, 15-37. [doi.org/10.1016/j.gca.2021.03.023](https://doi.org/10.1016/j.gca.2021.03.023).
- \*Zhu C, Rimstidt JD, <sup>G</sup>Zhang YL, <sup>G</sup>Kang JT, Schott J, Yuan HL (2020) Decoupling feldspar dissolution and precipitation rates at near-equilibrium with Si isotope tracers: Implications for modeling silicate weathering. *Geochimica et Cosmochimica Acta*. v271, 132-153. DOI: [10.1016/j.gca.2019.12.024](https://doi.org/10.1016/j.gca.2019.12.024).
- Gong L, Rimstidt JD<sup>†</sup>, <sup>G</sup>Zhang YL, Chen KY, \*Zhu C (2019) Unidirectional kaolinite dissolution rates at near-equilibrium and near-neutral pH conditions. *Applied Clay Science* v182, [doi.org/10.1016/j.clay.2019.105284](https://doi.org/10.1016/j.clay.2019.105284);
- <sup>G</sup>Zhang YL, Gong L, Chen KY, <sup>U</sup>Burkhart J, Yuan HL, \*Zhu C (2020) A method for Si isotope tracer kinetics experiments: Using Q-ICP-MS to obtain <sup>29</sup>Si/<sup>28</sup>Si ratios in aqueous solutions. *Chemical Geology* v531, [Doi: 10.1016/j.chemgeo.2019.119337](https://doi.org/10.1016/j.chemgeo.2019.119337);
- \*Zhu C, <sup>PD</sup>Liu ZY, <sup>PD</sup>Wang C, <sup>U</sup>Schaefer A, <sup>G</sup>Lu P, <sup>G</sup>Zhang GR, <sup>G</sup>Zhang YL, Georg RB, Rimstidt JD, Yuan HL (2016) Measuring silicate mineral dissolution rates using Si isotope doping. *Chemical Geology*, 445: 146-163, [doi:10.1016/j.chemgeo.2016.02.027](https://doi.org/10.1016/j.chemgeo.2016.02.027)
- <sup>PD</sup>Liu ZY, <sup>G</sup>Zhang YL, Yuan HL, Rimstidt JD, \*Zhu C (2016) A stable isotope doping method to test the range of applicability of detailed balance. *Geochemical Perspective Letters* 2(1): 78-86, [doi: 10.7185/78 geochemlet.1608](https://doi.org/10.7185/78_geochemlet.1608).
- <sup>G</sup>Liu Y, <sup>G</sup>Lu P, **Zhu C**, Xiao Y (2011) Coupled reactive transport modeling of CO<sub>2</sub> Sequestration in the Mt. Simon Sandstone Formation, Midwest U.S.A. *The International Journal of Greenhouse Gas Control* 52(2): 294-307, [doi: 10.1016/j.ijggc.2010.08.008](https://doi.org/10.1016/j.ijggc.2010.08.008).
- \*Zhu C and <sup>G</sup>Lu P (2009) alkali feldspar dissolution and secondary mineral precipitation in batch systems: 3. Saturation states of product minerals and reaction paths. *Geochimica et Cosmochimica Acta* 73: 3171-3120, [doi: 10.1016/j.gca.2009.03.015](https://doi.org/10.1016/j.gca.2009.03.015).
- Zhu C** (2005) In situ feldspar dissolution rates in an aquifer. *Geochimica et Cosmochimica Acta* 69(6): 1435-1453, [doi: 10.1016/j.gca.2004.09.005](https://doi.org/10.1016/j.gca.2004.09.005).
- Zhu C** (2000) Estimate of recharge from radiocarbon dating of groundwater and numerical flow and transport modeling. *Water Resources Research* 36(9): 2607-2620. <https://doi.org/10.1029/2000WR900172>.
- Zhu C** and Sverjensky DA (1991) Partitioning of F-Cl-OH between minerals and hydrothermal fluids. *Geochimica et Cosmochimica Acta* 55: 1837-1858.

## INVITED/KEYNOTE PRESENTATIONS

I have given 207 invited talks in my career and 90 invited talks in the last five years (2018-2023). I have given talks in the US, Canada, United Kingdom, Sweden, Germany, France, Switzerland, Norway, Poland, Spain, Saudi Arabia, United Arab Emirates, Israel, China, Japan, Slovenia, South Africa, and Brunei. [Click here for the list](#). Click here for some recordings: [1](#), [2](#), [3](#).