

Michael L. Szulczewski

mszulcz@mit.edu
<http://juanegroup.mit.edu/mszulcz>

EDUCATION

Massachusetts Institute of Technology

Cambridge, MA, USA

Candidate for PhD in Civil and Environmental Engineering

Advisor: R. Juanes

Research areas: fluid mechanics; flow & transport in porous media; geological storage of CO₂

Selected Coursework: Advanced Fluid Mechanics, Groundwater Hydrology, Water Quality Control, Sedimentary Geology, Seismology, Thermodynamics, Partial Differential Equations, Numerical Methods

SM in Civil and Environmental Engineering, June 2009

Advisor: R. Juanes

Thesis: "Storage Capacity and Injection Rate Estimates for CO₂ Sequestration in Deep Saline Aquifers in the Conterminous United States"

SB as Recommended by the Department of Earth, Atmospheric, and Planetary Science, June 2005

RESEARCH EXPERIENCE

Massachusetts Institute of Technology

Cambridge, MA, USA

Graduate Research Assistant, Juanes Research Group, Fall 2007 – present

Advisor: R. Juanes

- ▶ Migration and trapping of CO₂ in saline aquifers (theory and experiments)
- ▶ CO₂ dissolution in anticlines (theory and experiments)
- ▶ Multiphase flow in deformable porous media (theory and experiments)
- ▶ Mixing from viscous fingering of miscible fluids (experiments)

Tohoku University

Sendai, Japan

Researcher, Spring 2007 – Summer 2007

Advisor: K. Tsukamoto

- ▶ Heterogeneous nucleation of carbonates in geologic CO₂ sequestration (experiments)

Mitsubishi Materials Corporation

Tokyo, Japan

Researcher, Fall 2006 – Fall 2007

Advisor: A. Ueda

- ▶ Growth kinetics of calcium carbonate in CO₂ sequestration using interferometry (experiments)

Research Institute for Innovative Technologies for the Earth

Kyoto, Japan

Researcher, Fall 2005 – Fall 2006

Advisor: K. Yamada

- ▶ Dissolution of feldspar in CO₂ sequestration (experiments)

MIT Isotope Geochemistry and Geochronology Lab

Cambridge, MA, USA

Researcher, Summer 2004 – Summer 2005

Advisor: S. Bowring

- ▶ The origin and evolution of continental crust from U-Pb geochronology (experiments)

Teaching Experience

Advisor on eight MIT undergraduate research projects

- ▶ Aaron Thom, 2008: Drainage in porous media
- ▶ Michelle Bentivegna, Spring 2009: capillary trapping during geologic CO₂ sequestration
- ▶ Yingxia Wang, Summer 2009: Miscible viscous fingering in a Hele-Shaw cell
- ▶ Elise Hens, Fall 2009 - Spring 2010: Miscible and immiscible fingering in a Hele-Shaw cell
- ▶ Jared Darby, Summer 2011: Multiphase flow in deformable, granular porous media
- ▶ Di Jin, Fall 2011: Multiphase gravity currents in porous media
- ▶ Roberto Martinez, Fall 2011: Multiphase flow in deformable, granular porous media
- ▶ Michael Chen, Spring 2012: CO₂ convective dissolution

Professional Societies

American Physical Society, member

American Geophysical Union, member

Journal Publications

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers. Part 2. Capillary and solubility trapping. *Journal of Fluid Mechanics*, 688:321–351 (2011).

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers. Part 1. Capillary trapping under slope and groundwater flow. *Journal of Fluid Mechanics*, 662:329–351 (2010).

R. Juanes, C. W. MacMinn, and **M. L. Szulczewski**. The footprint of the CO₂ plume during carbon dioxide storage in saline aquifers: Storage efficiency for capillary trapping at the basin scale. *Transport in Porous Media*, 82(1):19–30 (2010).

Conference Papers

M. L. Szulczewski, C. W. MacMinn, and R. Juanes. How pressure buildup and CO₂ migration can both constrain storage capacity in deep saline aquifers. *Proceedings of the 10th International Conference on Greenhouse Gas Control Technologies (GHGT-9)*, Amsterdam, Netherlands, 2010. **Oral Presentation**

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers: Regimes in migration with dissolution. *Proceedings of the 10th International Conference on Greenhouse Gas Control Technologies (GHGT-10)*, Amsterdam, The Netherlands, 2010.

M. L. Szulczewski and R. Juanes. A simple but rigorous model for calculating CO₂ storage capacity in deep saline aquifers at the basin scale. *Proceedings of the 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9)*, Washington DC, USA, 2008. **Oral Presentation**

M. L. Szulczewski, L. Cueto-Felgueroso, and R. Juanes. Scaling of capillary trapping in unstable two-phase flow: Application to CO₂ sequestration in deep saline aquifers. *Proceedings of the 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9)*, Washington DC, USA, 2008.

Conference Abstracts (selected)

C. W. MacMinn, **M. L. Szulczewski**, J. J. Hidalgo, and R. Juanes. Gravity currents arrested by convective mixing. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2011. **Oral Presentation**

M. L. Szulczewski and R. Juanes. How convective mixing slows down. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2011. Poster

R. Holtzman, **M. L. Szulczewski**, J. Darby, and R. Juanes. Crossover from fingering to fracturing in fluid-fluid displacement in deformable granular media: theory and experiments. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2011. **Oral Presentation**

J. Chui, **M. L. Szulczewski**, B. Jha, and R. Juanes. Understanding the evolution of miscible viscous fingering patterns. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2011. Poster

R. Zhao, C. W. MacMinn, **M. L. Szulczewski**, J. Neufeld, H. E. Huppert, and R. Juanes. Capillary pinning and the multiphase lock-exchange problem in porous media. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2011. **Oral Presentation**

M. L. Szulczewski and R. Juanes. How convective mixing slows down. *64th Annual Meeting of the American Physical Society Division of Fluid Dynamics*, Baltimore, MD, 2011. **Oral Presentation**

R. Juanes, C. W. MacMinn, **M. L. Szulczewski**, B. Zhao, J. A. Neufeld, and H. E. Huppert. Residual trapping and capillary pinning of a CO₂ gravity current: theory and experiments. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2010. **Oral Presentation**

M. L. Szulczewski, C. W. MacMinn, and R. Juanes. Dissolution rate of CO₂ during geologic sequestration: simple experiments and simulations of density-driven Rayleigh-Benard instabilities. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2010. Poster

T. Perron, P. Myrow, J. B. Southard, K. L. Huppert, and **M. Szulczewski**. Defect dynamics in wave ripples. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2010. **Invited Oral Presentation**

R. Juanes, C. W. MacMinn, and **M. L. Szulczewski**. CO₂ migration in saline aquifers: a gravity current model with capillary and solubility trapping. *63rd Annual Meeting of the American Physical Society Division of Fluid Dynamics*, Long Beach, CA, USA, 2010. **Oral Presentation**

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers with capillary trapping and dissolution under slope and groundwater flow. *Gordon Research Conference on Flow & Transport in Permeable Media*, Lewiston, ME, 2010. Poster

M. L. Szulczewski, and R. Juanes. Dissolution Rate of CO₂ during geologic sequestration: simple experiments on density-driven Rayleigh-Benard instabilities in a Hele-Shaw cell. *Gordon Research Conference on Flow & Transport in Permeable Media*, Lewiston, ME, 2010. Poster

M. L. Szulczewski, C. W. MacMinn, L. Cueto-Felgueroso, and R. Juanes. Suppression of mixing in miscible viscous fingering in a Hele-Shaw cell. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2009. Poster, **Winner of Outstanding Student Paper Award**

R. Juanes, C. W. MacMinn, and **M. L. Szulczewski**. CO₂ storage capacity estimates from fluid dynamics. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2009. **Invited Oral Presentation**

C. W. MacMinn, **M. L. Szulczewski**, L. Cueto-Felgueroso, and R. Juanes. Experimental characterization of immiscible viscous fingering in a Hele-Shaw cell. *Fall Meeting of the American Geophysical Union*, San Francisco, CA, 2009. Poster

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers with slope and groundwater flow. *62nd Annual Meeting of the American Physical Society Division of Fluid Dynamics*, Minneapolis, MN, USA, 2009. **Oral Presentation**

C. W. MacMinn, **M. L. Szulczewski**, and R. Juanes. CO₂ migration in saline aquifers with slope and groundwater flow. *Workshop on Modeling and Risk Assessment of Geological CO₂ Storage*, Svalbard, Norway, 2009. Poster