

CURRICULUM VITAE

Martin O. Saar
 Institute of Geophysics
 Dept. of Earth Sciences, ETH Zürich
 Sonnegstr. 5, 8092 Zürich, Switzerland

Email: saarm@ethz.ch
 Web: www.geophysics.ethz.ch
 Office: NO Building: Room: F-51.2
 Phone: +41 44 632 34 65 (office admin)

RESEARCH FIELD

Geophysical fluid dynamics research of subsurface multiscale, multiphase, multicomponent, reactive fluid (groundwater, hydrocarbon, CO₂) and energy (heat, pressure) transport such as water- and CO₂-based geothermal energy utilization, geologic CO₂ storage, grid-scale energy storage, enhanced oil recovery, and groundwater flow. Methods include computer simulations, laboratory experiments, and field analyses.

POSITIONS

Academic: (UMN=University of Minnesota-Minneapolis, ETH=Swiss Federal Institute of Technology)

2015-present **Endowed* Chair and Professor for Geothermal Energy and Geofluids**, Institute of Geophysics, Dept. of Earth Sciences, ETH-Zürich, CH; (*by Werner Siemens Foundation)
 2015-present Adjunct Professor of Hydrogeology and Geofluids, Dept. of Earth Sciences, UMN, USA
 2014 **Professor** (Fall, 2014), Dept. of Earth Sciences, UMN, USA
 2011-present Institute on the Environment Resident Fellow, UMN, USA
 2011-2014 **Associate Professor**, Dept. of Earth Sciences, UMN, USA
 2009-2011 **McKnight Land-Grant Chair & Professor**, College of Science & Engineering, UMN, USA
 2008-present Affiliated Member of the Graduate Faculty, Computer Science and Engineering, UMN, USA
 2006-present Member of the Graduate Faculty, Water Resources Sciences, UMN, USA
 2005-2014 **Gibson Chair of Hydrogeology and Geofluids**, UMN, USA
 2005-2011 **Assistant Professor**, Dept. of Geology and Geophysics (later Earth Sciences), UMN, USA
 2003-2004 Turner Postdoctoral Fellow, Dept. of Earth and Environm. Sci., U. of Michigan, MI, USA

Industry:

2014-present Co-Founder & Chief Scientific Officer, TerraCOH, a COH-Geothermal Co., Mpls., MN, USA
 2012-present Founder & Chief Manager, Geofluids LLC, a geofluids consulting firm, St. Paul, MN, USA
 2011-present Co-Founder & Chief Scientific Officer, Heat Mining Company LLC, Rapid City, SD, USA

EDUCATION

2003 Ph.D. in Earth and Planetary Sciences, University of California, Berkeley, CA; Adviser: Dr. Michael Manga; Dissertation: *Geological Fluid Mechanics Models at Various Scales*
 1998 M.S. in Geology, University of Oregon, Eugene, OR; Adviser: Dr. Michael Manga; Thesis: *The Relationship Between Permeability, Porosity, and Microstructure in Vesicular Basalts*
 1995 Vordiplom (~B.S.) in Geology, Albert-Ludwigs University, Freiburg, Germany

AWARDS AND PATENTS

2014-present Saar, M.O., Randolph, J.B., Kuehn, T.H., the Regents of the University of Minnesota, and Heat Mining Company LLC, Geothermal energy generation system comprises injection wells for accessing reservoir containing native fluid comprising hydrocarbon, production wells, non-water based working fluid supply apparatus, and energy recovery apparatus, Pending Patent No. WO2014015307-A1.
 2012-2015 Saar, M.O., Randolph, J.B., Kuehn, T.H., & the Regents of the University of Minnesota, Carbon dioxide-based geothermal energy generation systems and methods related thereto, U.S. Patent No. US8,316,955 B2 (issued 2012); Canada Patent No. 2.753.393 (issued 2013); Europe Patent No. 2406562 (issued 2014); Australia Patent No. 2010223059 (issued 2015).

- 2012 U.S. Patent Application for CPG with Enhanced Oil Recovery (EOR), i.e., CPG-EOR (continuation-in-part of CPG parent patent; patent application number: 13/554,868; pending)
- 2011 George W. Taylor Career Development Award for top tenure candidate in the College of Science and Engineering, University of Minnesota – Twin Cities
- 2011 Editor's Choice Award for 2011 Hydrogeology Journal article (see publications: Saar, 2011)
- 2009 Awarded 2009-2011 McKnight Land-Grant Professorship and Chair position, UMN
- 2005 Awarded endowed Gibson Chair position, University of Minnesota
- 2004 Awarded Turner Postdoctoral Fellowship, University of Michigan
- 2000 Outstanding Student Paper Award, American Geophysical Union
- 1997 Awarded: Staples Fellowship for Outstanding Scholastic Achievements, University of Oregon

MEMBERSHIPS

- 2015-present International Geothermal Association (IGA)
- 1997-present American Geophysical Union (AGU)

REFEREED PUBLICATIONS

Current or former student, postdoc, or researcher advisees are *italicized*. For positions, see Advising Section.

- 49) *Tutolo, B.M., X.-Z. Kong*, W.E. Seyfried Jr., and M.O. Saar, High performance reactive transport simulations examining the effects of thermal, hydraulic, and chemical (THC) gradients on fluid injectivity at carbonate CCUS reservoir scales, **Int. J. Greenhouse Gas Control**, 39, 285-301, 2015.
- 48) *Tutolo, B.M., A.J. Luhmann, X.-Z. Kong*, M.O. Saar, and W.E. Seyfried Jr., CO₂ sequestration in feldspar-rich sandstone: Coupled evolution of fluid chemistry, mineral reaction rates, and hydrogeochemical properties, **Geochimica et Cosmochimica Acta**, 160 (2015) 132–154, DOI: 10.1016/j.gca.2015.04.002, 2015.
- 47) *Garapati, N., J.B. Randolph*, and M.O. Saar, Brine displacement by CO₂, energy extraction rates, and lifespan of a CO₂-limited CO₂ Plume Geothermal (CPG) system with a horizontal production well, **Geothermics**, 55, 182–194, 2015.
- 46) *Adams, B.M., T.H. Kuehn, J.M. Bielicki, J.B. Randolph*, M.O. Saar, A Comparison of Electric Power Output of CO₂ Plume Geothermal (CPG) and Brine Geothermal Systems for Varying Reservoir Conditions, **Applied Energy** 140, 365–377, 2015.
- 45) *Luhmann, A.J., M. D. Covington, J.M. Myre, M. Perne, S.W. Jones, E.C. Alexander, Jr., and M.O. Saar*, Thermal damping and retardation in karst conduits, **Hydrology and Earth System Sciences (HESS)**, 19, 137-157, doi:10.5194/hess-19-137-2015, 2015.
- 44) *Buscheck, T.A., J.M. Bielicki, M. Chen, Y. Sun, Y. Hao, T.A. Edmunds, M.O. Saar, and J.B. Randolph*, Integrating CO₂ Storage with Geothermal Resources for Dispatchable Renewable Electricity, **Energy Procedia**, 63, 7619-7630, 2014.
- 43) *Garapati, N., J.B. Randolph, J.L. Valencia Jr.*, and M.O. Saar, CO₂ -Plume Geothermal (CPG) Heat Extraction in Multi-layered Geologic Reservoirs, **Energy Procedia**, 63, 7631–7643, 2014.
- 42) *Tutolo, B.M., A.T. Schaen, M.O. Saar, and W.E. Seyfried Jr.*, Implications of the redissociation phenomenon for mineral-buffered fluids and aqueous species transport at elevated temperatures and pressures, **Applied Geochemistry**, <http://dx.doi.org/10.1016/j.apgeochem.2014.11.002>, 2014.
- 41) *Luhmann, A.J., X.-Z. Kong, B.M. Tutolo, N. Garapati, B.C. Bagley, M.O. Saar, and W.E. Seyfried Jr.*, Experimental dissolution of dolomite by CO₂-charged brine at 100°C and 150 bar: Evolution of porosity, permeability, and reactive surface area, **Chemical Geology**, 380, 145-160, 2014.
- 40) *Adams, B.M., T.H. Kuehn, J.M. Bielicki, J.B. Randolph, and M.O. Saar*, On the importance of the thermosiphon effect in CPG (CO₂ Plume Geothermal) power systems, **Energy**, 69, 409-418, 2014.
- 39) *Tutolo, B.M., X.-Z. Kong, W.E. Seyfried, Jr., and M.O. Saar*, Internal consistency in aqueous geochemical data revisited: Applications to the aluminum system, **Geochimica et Cosmochimica Acta**, 133, 216–234, 2014.

- 38) *Tutolo, B.M., A.J. Luhmann, X.-Z. Kong, M.O. Saar, and W.E. Seyfried Jr.*, Experimental observation of permeability changes in dolomite at CO₂ sequestration conditions, **Environmental Science and Technology**, DOI: 10.1021/es4036946, 2014.
- 37) *Kong, X.-Z., and M.O. Saar*, Numerical study of the effects of permeability heterogeneity on density-driven convective mixing during CO₂ dissolution storage, **Int. J. Greenhouse Gas Control**, <http://dx.doi.org/10.1016/j.ijggc.2013.08.020>, 19, 160-173, 2013.
- 36) *Adams, B.M., T.H. Kuehn, J.B. Randolph, M.O. Saar*, The reduced pumping power requirements from increasing the injection well fluid density, **Geothermal Resources Council (GRC) Transactions**, in press, 2013.
- 35) *Randolph, J.B., M.O. Saar, and J. Bielicki*, Geothermal energy production at geologic CO₂ sequestration sites: Impact of thermal drawdown on reservoir pressure, **Energy Procedia**, 37, 6625-6635, 2013.
- 34) *Gottardi, R., P.-H. Kao, M.O. Saar, and C. Teyssier*, Effects of permeability fields on fluid, heat, and oxygen isotope transport in extensional detachment systems, **Geochemistry Geophysics Geosystems**, DOI: 10.1002/ggge.20100, 1-30, 2013.
- 33) *Luhmann, A.J., X.-Z. Kong, B.M. Tutolo, K. Ding, M.O. Saar, and W.E. Seyfried, Jr.*, Permeability reduction produced by grain reorganization and accumulation of exsolved CO₂ during geologic carbon sequestration: A new CO₂ trapping mechanism, **Environmental Science and Technology**, Special Issue: Carbon Sequestration, dx.doi.org/10.1021/es3031209, 47, 242-251, 2013.
- 32) *Walsh, S.D.C., and M.O. Saar*, Developing extensible lattice-Boltzmann simulators for general-purpose graphics-processing units, **Communications in Computational Physics**, Vol. 13, No. 3, pp. 867-879, doi: 10.4208/cicp.351011.260112s, 2013.
- 31) *Kong, X.-Z., B.M. Tutolo, and M.O. Saar*, DBCreate: A SUPCRT92-based program for producing EQ3/6, TOUGHREACT, and GWB thermodynamic databases at user-defined T and P, **Computers and Geosciences**, 51, 415-417, doi:10.1016/j.cageo.2012.08.004, 2013.
- 30) *Randolph, J.B., B.M. Adams, T.H. Kuehn, and M.O. Saar*, Wellbore heat transfer in CO₂-based geothermal systems, **Geothermal Resources Council (GRC) Transactions**, 36, 549-554, 2012.
- 29) *Covington, M.D., A.J. Luhmann, C.M. Wicks, and M.O. Saar*, Process length scales and longitudinal damping in karst conduits, **Journal of Geophysical Research - Earth Surface**, 117, F01025, doi:10.1029/2011JF002212, 2012.
- 28) *Alexander, S.C., and M.O. Saar*, Improved characterization of small "u" for Jacob pumping test analysis methods, **Ground Water**, DOI: 10.1111/j.1745-6584.2011.00839.x, 2012.
- 27) *Covington, M.D., A.F. Banwell, J. Gulley, M.O. Saar, I. Willis, C.M. Wicks*, Quantifying the effects of glacier conduit geometry and recharge on proglacial hydrograph form, **Journal of Hydrology**, doi:10.1016/j.jhydrol.2011.10.027, 2012.
- 26) *Covington, M.D., A.J. Luhmann, F. Gabrovsek, M.O. Saar, and C.M. Wicks*, Mechanisms of heat exchange between water and rock in karst conduits, **Water Resources Research**, 47, W10514, doi:10.1029/2011WR010683, 2011.
- 25) *Randolph, J.B., and M.O. Saar*, Impact of reservoir permeability on the choice of subsurface geothermal heat exchange fluid: CO₂ versus water and native brine, **Geothermal Resources Council (GRC) Transactions**, 35, 521-526, 2011.
- 24) *Randolph, J.B., and M.O. Saar*, Combining geothermal energy capture with geologic carbon dioxide sequestration, **Geophysical Research Letters**, 38, L10401, doi:10.1029/2011GL047265, 2011.
- 23) *Davis, M.A., S.D.C. Walsh, and M.O. Saar*, Statistically reconstructing continuous isotropic and anisotropic two-phase media while preserving macroscopic material properties, **Physical Review E**, 83, 026706, DOI: 10.1103/PhysRevE.83.026706, 2011.
- 22) *Randolph, J.B. and M.O. Saar*, Coupling carbon dioxide sequestration with geothermal energy capture in naturally permeable, porous geologic formations: Implications for CO₂ sequestration, **Energy Procedia**, 4, 2206-2213, DOI: 10.1016/j.egypro.2011.02.108, 2011.
- 21) *Saar, M.O.*, Review: Geothermal heat as a tracer of large-scale groundwater flow and as a means to determine permeability fields, special theme issue on Environmental Tracers and Groundwater Flow, editor-invited peer-reviewed contribution, **Hydrogeology Journal**, 19:31-52, DOI 10.1007/s10040-010-0657-2, 2011. *A Hydrogeology Journal Editor's Choice Article in 2011.*
- 20) *Walsh, S.D.C., and M.O. Saar*, Interpolated lattice-Boltzmann boundary conditions for surface reaction

- kinetics, **Physical Review E**, 82, 066703, DOI: 10.1103/PhysRevE.82.066703, 2010.
- 19) Dasgupta, S., M.O. Saar, R.L. Edwards, C.-C. Shen, H. Cheng, E.C. Alexander Jr., Three thousand years of extreme rainfall events recorded in stalagmites from Spring Valley Caverns, Minnesota, **Earth and Planetary Science Letters**, doi:10.1016/j.epsl.2010.09.032, 2010.
 - 18) Myre, J., S.D.C. Walsh, D.J. Lilja, and M.O. Saar, Performance analysis of single-phase multiphase, and multicomponent lattice-Boltzmann fluid flow simulations on GPU clusters, **Concurrency and Computation: Practice and Experience**, DOI: 10.1002/cpe.1645, 2010.
 - 17) Randolph, J.B. and M.O. Saar, Coupling geothermal energy capture with carbon dioxide sequestration in naturally permeable, porous geologic formations: A comparison with enhanced geothermal systems, **Geothermal Resources Council (GRC) Transactions**, Vol. 34, pp. 433-438, 2010.
 - 16) Walsh, S.D.C., and M.O. Saar, Macroscale lattice-Boltzmann methods for low-Peclet-number solute and heat transport in heterogeneous porous media, **Water Resources Research**, 46, W07517, doi:10.1029/2009WR007895, 2010.
 - 15) Covington, M.D., C.M. Wicks, and M.O. Saar, A dimensionless number describing the effects of recharge and geometry on discharge from simple karst aquifers, **Water Resources Research**, 45, W11410, doi:10.1029/2009WR008004, 2009.
 - 14) Bailey, P., J. Myre, S.D.C. Walsh, D.J. Lilja, and M.O. Saar, Accelerating Lattice Boltzmann Fluid Flow Simulations Using Graphics Processors, 38th International Conference on Parallel Processing (ICPP), strictly peer-reviewed conference proceedings publication, pp. 550-557, 2009.
 - 13) Walsh, S.D.C., M.O. Saar, P. Bailey, and D.J. Lilja, Acceleration of geo-science and engineering system simulations on graphics hardware, **Computers and Geosciences**, doi:10.1016/j.cageo.2009.05.001, 2009.
 - 12) Walsh, S.D.C., H. Burwinkle, and M.O. Saar, A new partial-bounceback lattice-Boltzmann method for fluid flow through heterogeneous media, **Computers and Geosciences**, doi:10.1016/j.cageo.2008.05.004, 2009.
 - 11) Walsh, S.D.C., and M.O. Saar, Magma yield stress and permeability: Insights from multiphase percolation theory; **Journal of Volcanology and Geothermal Research**, 177, 1011–1019, doi:10.1016/j.volgeo.2008.07.009, 2008.
 - 10) Walsh, S.D.C., and M.O. Saar, Numerical Models of Stiffness and Yield Stress Growth in Crystal-Melt Suspensions, **Earth and Planetary Science Letters**, doi:10.1016/j.epsl.2007.11.028, 2008.
 - 9) Edwards, R.A., B. Rodriguez-Brito, L. Wegley, M. Haynes, M. Breitbart, D.M. Peterson, M.O. Saar, S.C. Alexander, E.C. Alexander Jr., F. Rohwer, Using pyrosequencing to shed light on deep mine microbial ecology, **BMC Genomics**, doi:10.1186/1471-2164-7-57, 2006.
 - 8) Christiansen, L.B., S. Hurwitz, M.O. Saar, S.E. Ingebritsen, P.A. Hsieh, Seasonal seismicity at western United States volcanic centers, **Earth and Planetary Science Letters**, 240, 307-321, 2005.
 - 7) Saar, M.O., M.C. Castro, C.M. Hall, M. Manga, and T.P. Rose, Quantifying magmatic, crustal, and atmospheric helium contributions to volcanic aquifers using all stable noble gases: Implications for magmatism and groundwater flow, **Geochemistry Geophysics Geosystems**, Vol. 6, Nr. 3, Q03008, doi:10.1029/2004GC000828, 2005.
 - 6) Saar, M.O., and M. Manga, Depth dependence of permeability in the Oregon Cascades inferred from hydrogeologic, thermal, seismic, and magmatic modeling constraints, **Journal of Geophysical Research**, Vol. 109, Nr. B4, B04204, doi:10.1029/2003JB002855, 2004.
 - 5) Jellinek, A.M., M. Manga, and M.O. Saar, Did melting glaciers cause volcanic eruptions in eastern California? Probing the mechanics of dike formation, **Journal of Geophysical Research**, Vol. 109, Nr. B9, B09206, doi:10.1029/2004JB002978, 2004.
 - 4) Saar, M.O., and M. Manga, Seismicity induced by seasonal groundwater recharge at Mt. Hood, Oregon, **Earth and Planetary Science Letters**, Vol. 214, 605-618, 2003
 - 3) Saar, M.O., and M. Manga, Continuum percolation for randomly oriented soft-core prisms, **Physical Review E**, Vol. 65, 056131-1 to 6, 2002.
 - 2) Saar, M.O., M. Manga, K. Cashman, and S. Fremouw*, Numerical models of the onset of yield strength in crystal-melt suspensions, **Earth and Planetary Science Letters**, Vol. 187, 367-379, 2001.
- (* Sean Fremouw was an undergraduate student supervised by Saar, a graduate student at the time.)

- 1) Saar, M.O., and M. Manga, Permeability-porosity relationship in vesicular basalts, **Geophysical Research Letters**, Vol. 26, No. 1, 111-114, 1999.

SELECTED CONFERENCE PROCEEDINGS (since 2015)

- Saar, M.O.**, T.A. Buscheck, P. Jenny, *N. Garapati, J.B. Randolph*, D.C. Karvounis, M. Chen, Y. Sun, and J.M. Bielicki, Numerical Study of Multi-Fluid and Multi-Level Geothermal System Performance, Peer-Reviewed Proceedings of the World Geothermal Congress, Melbourne, Australia, 19-25 April, 2015.
- Buscheck, T.A., J.M. Bielicki, M. Chen, Y. Sun, Y. Hao, T.A. Edmunds, *J.B. Randolph*, and **M.O. Saar**, Multi-Fluid Sedimentary Geothermal Energy Systems for Dispatchable Renewable Electricity, Proceedings to the World Geothermal Congress, Melbourne, Australia, 19-25 April, 2015.

ADVISING / SUPERVISING OF EMPLOYEES:

Current/Future at ETH-Zürich, Switzerland (new group to be set up – expected final size: about 30):

2015-present	Dominique Ballarin	Office, Computer System, and Intra+Internet Administrator
2015-present	Dr. Xiang-Zhao Kong	Senior Researcher (OA): Experiments, pore-scale models
2015-present	TBD (current applications)	Senior Researcher (OA): Numerical reservoir modeling
2015 (June)-	Dr. Keith Evans	Senior Researcher (~OA): Field / Deep Mine Investigations
2015 (March)-	Dr. Friedemann Samrock	Postdoc, Magnetotellurics (MT) and other field geophysics
2015 (May)-	Dr. Nagasree Garapati	Postdoc, Ph.D. in Chemical Engineering, W. Virginia U.
2015 (Sep.)-	Dr. Allan Leal	Postdoc, Ph.D. in Reaction Modeling, Imperial College, UK
2015 (May)-	Anniina Kittilä	Ph.D. Student in Enhanced Geothermal System Investigation
2015 (July)-	Claudia Deuber	M.S. Student in Enhanced Geothermal System Investigation
2015 (July)-	Neraj Shaw	M.S. Student in Geothermal System Exploration Geophysics
2015 (Dec.)-	Nils Knornschild	Laboratory and Field Technician (50%, other 50% with SSCER)
2015-present	TBD (current applications)	Postdocs, Ph.D. Students, M.S. Students, B.S. Students
2015-present	SCCER-SoE	Co-supervision of Swiss Competence Center on Energy Research – Supply of Electricity (SCCER – SoE) personnel which focuses on 1) Geothermal Energy, 2) geologic CO ₂ storage.

+ three more employees at the University of Minnesota (UMN), USA (see below).

+ as external private consultant (Applied Mathematician and Computer Programmer), former postdoc and senior Research associate, Dr. Stuart Walsh (located in Sydney, Australia).

Current at UMN, USA:

Junior Scientist, Lab and Project Manager:

2006-present Scott C. Alexander (partial (majority) support, permanent)

Post-doctoral and Research Associates:

2011-present Dr. Jimmy Randolph (Ph.D. in Geophysics, UMN, with Saar; research Associate)

2015-present Dr. Ben Adams (co-advised by Prof. T. Kuehn, Mechanical Engineering; Ph.D. May, 2015, in Mechanical Engineering; Since June 2015: Postdoc with Saar and Kuehn at UMN.)

Former at UMN, USA:Research Associates:

2008-2010	Dr. Matt Covington	(Ph.D. 2008, UCSC in Astrophysics, now Geology Professor at U. of Arkansas; co-advised with Prof. Wicks, Louisiana State U.)
2009-2011	Dr. Stuart Walsh	(Ph.D. 2005, Melbourne, Applied Math, now Research Scientist at Lawrence Livermore National Laboratory, CA)

Post-doctoral Associates:

2013-04/2015	Dr. Nagasree Garapati	(Ph.D. in Chemical Engineering, Postoc)
2010-2013	Dr. Xiang-Zhao Kong	(Ph.D. 2010, Environmental Engineering, ETH-Zürich , CH 2014: at University of Queensland, Brisbane, Australia)
2009-2011	Dr. Po-Hao Kao	(Ph.D. 2007, Nation. Cheng Kung U., Taiwan, Engineering, now Senior Thermal Mechanical Engineer at Corning Inc.)
2006-2009	Dr. Stuart Walsh	(Ph.D. 2005, Melbourne, Applied Math, now Research Scientist at Lawrence Livermore National Laboratory, CA)

Ph.D. Students (year = degree received):

2015	Dr. Ben Tutolo	(co-advised with Bill Seyfried Jr.; B.S. in Env. Syst. Eng., Penn State; Ph.D., May 2015, in Aqueous Geochemistry and Geophysics; Since June 2015: Postdoc at Oxford University, GB)
2015	Dr. Ben Adams	(co-advised by Prof. T. Kuehn, Mechanical Engineering; Ph.D. May, 2015, in Mechanical Engineering; Since June 2015: Postdoc with Saar and Kuehn at UMN.)
2013	Dr. Joseph Myre	(Ph.D. in Computer Science with Saar and Lilja as advisers; received NSF Earth Sciences postdoc and started Sep. 1, 2013, with Saar's former postdoc, Dr. Covington, as Myre's postdoc adviser)
2011	Dr. Jimmy Randolph	(Ph.D. degree in Geophysics; also a current postdoc with Saar and a private consultant for Heat Mining Company LLC)

M.S. Students (year = degree received):

2013	Jennifer Meester	(M.S. degree in Water Resources Science, 2013)
2009	Ravi Appana	(M.S. degree in Geophysics, 2009, now Hydrogeology Consultant at Environmental Resources Management (ERM), India division)
2008	Judy Andrews	(M.S. degree in Geophysics)

Undergraduate Students (UMN) (year = degree received):

2013	Brian Demet	(B.S. in Geology, Undergraduate Research Opportunity (UROP))
2011	Ryan Toot	(B.S. in Geoen지니어ing)
2009	Alex Morrison	(B.S. in Geology, transferred from Computer Science)
2008	Lillian Gorman	(B.S. in Geology, Geophysics, supported by UROP)
2008	Karli Anderson	(B.S. in Geology, Geophysics, IT Honors Thesis)
2008	Ryan O'Grady	(B.S. in Geology, Geophysics, UROP, now at the LRC at UMN)
2007	Steve Pinta	(B.S. in Geology, Geophysics)
2006	Julian (Nino) d'Andrea	(B.A. in Geology; UROP project)
2006	Abbey Duncan	(B.S. in Geology; UROP project & senior thesis)

Undergraduate Students (NSF-REU Summer Interns):

2013	Zoe Wu	(from Rice University)
2012	Daniel Friedman	(from Boston University)
2011	Gabriel Lotto	(from Binghamton University)
2010	Joseph Nelson	(from University of Virginia, now Ph.D. student at Stanford)

2009	Ben Tutolo	(from Penn State University, now Ph.D. student with Saar)
2008	Alina Blinova	(from Cornell University)
2008	Rachel Bernard	(from Princeton University)
2007	Holly Burwinkle	(from Clemson University, in Math)
2007	Danielle Grogan	(from Smith College)

Service on graduate committees at UMN since 2005:

Own students, listed above, are not listed in the table below.

<u>Name</u>	<u>Academic Plan</u>	<u>Degree</u>	<u>Status</u>	<u>Saar's Role</u>
Anger, Cale	Geol	M.S.	Completed	M.S. Final Member
Bagley, Brian	Geophys	Ph.D.	Completed	Ph.D. Final Reader
Bauer-Reich, Cherish	Geophys	Ph.D.	Active	Ph.D. Prelim Member
Blanksma, Derrick	Geoengr	M.S.	Completed	M.S. Final Member
Bordoloi, Ankur	AeroEM	Ph.D.	Active	Ph.D. Final Member
Flemming, Mark	MechEng	Ph.D.	Active	Ph.D. Prelim Member
Gottardi, Raphael	Geol	Ph.D.	Completed	Ph.D. Prelim Member
Janke, Brian	Mech Engr	M.S./M.E.	Completed	M.S. Final Member
King, Daniel	Geophys	Ph.D.	Completed	Ph.D. Final Member
Larkin, Lauren	Geophys	M.S.	Completed	M.S. Final Member
Luhmann, Andrew	Geol	Ph.D.	Completed	Ph.D. Final Chair/Reader
Makhnenko, Roman	CivilEng	Ph.D.	Completed	Ph.D. Final Member
Mascarenhas, Daniel	MechEng	M.S./M.E.	Completed	M.S. Final Member
Qi, Chao	Geophys	Ph.D.	Active	Ph.D. Final Member
Sawyer, Charles	MechEngr	M.S./M.E.	Completed	M.S. Final Member
Stanley, Benjamin	Geol	Ph.D.	Completed	Ph.D. Final Member
Tipping, Robert	WaterResSc	Ph.D.	Completed	Ph.D. Final Member
Toraman, Erkan	Geol	Ph.D.	Active	Ph.D. Prelim Member
Wang, Tao	Geophys	Ph.D.	Completed	Ph.D. Reviewer

INVITED TALKS (at Department Seminar Series, Conferences, Organizations; up-coming and past)

11/23/2015	Rotary Club near Zürich, Switzerland, Title: TBA (<i>Geothermal Energy</i>)
11/12/2015	Freie Universität Berlin, Germany, Title: TBA (<i>Geothermal Energy</i>)
09/25/2015	New Energy Forum-2015, Xi'an, China, Title: <i>New Geothermal Energy Technologies: Combinations with CO₂ Storage and Superheating.</i>
09/16/2015	GEOTHERMIE.CH (Schweizerischen Vereinigung für Geothermie) und das Bundesamt für Energie, BFE, Roundtable Gespräch: Tiefe Geothermie, Title: <i>Effiziente Umwandlung von geothermischen Flüssigkeiten und deren Energie</i>
06/02/2015	Gordon Research Conference on Carbon Capture, Utilization, and Storage, May 31 - June 5, 2015, Stonehill College Easton, MA, USA: Title: <i>Combining geologic CO₂ Sequestration with Geothermal Energy Utilization</i>
05/21/2015	Fourth Internationaler Geothermie-Kongress 2015, St. Gallen, Switzerland, Title: <i>Hybrid-Systeme zur geothermischen Energie- und Treibstoffentwicklung bei niedrigen Untergrund-Temperaturen oder Flussraten</i>
05/11/2015	ETH-Zürich, Switzerland, Inaugural Lecture, Title: <i>Moving Mountains ... and Other Uses of Geothermal Energy.</i>
04/24/2015	World Geothermal Congress – Melbourne, Australia: Title: <i>Numerical Study of Multi-Fluid and Multi-Level Geothermal System Performance.</i>

- 11/25/2014 RWTH-Aachen, Title: *Extracting Geothermal Energy While Storing CO₂*.
- 10/14/2014 Society of Petroleum Engineers (SPE), German Section (GSSPE), Hannover, Germany: Title: *Combining geothermal energy production with CO₂ storage and enhanced oil recovery*
- 10/10/2014 Dept. of Earth Sciences, ETH-Zürich, Switzerland, Title: *The Geothermal Energy and Geofluids Group at ETH-Zürich: Background and Vision*
- 09/26/2014 Columbia University, New York, NY, Title: *Heat and Fluid Mining in the 21st Century – Sustainable Energy Supply Reducing Climate Change*
- 05/16/2014 Northwestern University, Chicago, Northwester Climate Change Symposium, Title: *CO₂ – Use it or lose it! How CO₂ can be used to extract geothermal energy instead of being lost to the atmosphere.*
- 03/11/2014 Technical University Munich, Germany, Conference/Workshop: Science transfer for the further expansion of deep geothermics in the southern German Molasse Basin, Title: *Using CO₂ as a heat extraction fluid in sedimentary geothermal systems – possibly an approach for the Molasse Basin*
- 10/25/2013 Queen’s University, Kingston, Ontario, Canada: Title: *Geofluid dynamics in sedimentary basins.*
- 10/20/2013 Keynote talk at the Penrose Conference in Park City, Utah, entitled: Predicting and Detecting Natural and Induced Flow Paths for Geothermal Fluids in Deep Sedimentary Basins: Talk Title: *Permeability Effects on Water- and CO₂-Based Heat Transfer*
- 09/06/2013 ETH-Zürich, Switzerland: Title: Enhancing geothermal system performance – From enhanced permeability to CO₂-enhanced heat extraction efficiency
- 05/21/2013 Northwestern University, Chicago, McCormick Fluids and Transport Seminar Series: Title: *Simulations and lab experiments of reactive multicomponent, multiphase fluid flow during geologic CO₂ sequestration and geothermal energy capture*
- 05/16/2013 Lawrence Livermore National Laboratory, Livermore, CA; Title: *Permeability reduction by grain reorganization and accumulation of exsolved CO₂ during geologic carbon sequestration: A new CO₂ trapping mechanism*
- 10/12/2012 Midwest Groundwater Conference, Minneapolis, MN: Title: *The multi-functionality of geologically sequestered carbon dioxide: From geothermal energy extraction to renewable energy storage.*
- 09/24/2012 New Horizons Oil and Gas Conference, Rapid City, SD, Title: *Using carbon dioxide as a geothermal heat mining fluid to pay for its geologic sequestration.*
- 09/21/2012 University of North Dakota; Title of general talk: *A new way to employ renewable geothermal energy in more regions worldwide.* Title of 2nd, more in-depth talk: *Reactive multiphase fluid flow during CO₂ sequestration and CO₂-based geothermal energy extraction.*
- 06/27/2012 Geoforschungszentrum Potsdam, Germany, Title: *Combining Geothermal Energy Extraction and CO₂ Sequestration to Produce Clean, Renewable Carbon-Negative Electricity*
- 03/26/2012 Alberta Innovates (Calgary) Workshop: Integrated Geothermal and CO₂ Storage Systems - Using CO₂ as the geothermal fluid: Technical issues and relevance to CCS and energy conversion systems, Title: *CO₂ Plume Geothermal (CPG) 1: Geothermal systems using CO₂ as the subsurface heat exchange fluid in naturally permeable geologic formations -- general concepts.*
- 02/18/2012 University of Minnesota, Carlson School of Management, 3M Seminar Series, Title: *Experiences commercializing CO₂-Plume Geothermal through Heat Mining Company LLC.*
- 11/21/2011 American Physical Society – Division of Fluid Dynamics, Title: *Multiphase, multicomponent simulations and experiments of reactive flow, relevant for combining geologic CO₂ sequestration with geothermal energy capture.*
- 11/07/2011 E3 Conference, Institute on the Environment (IonE), Initiative for Renewable Energy and the Environment (IREE), University of Minnesota, Title: *Combining Geothermal Energy Capture with CO₂ Sequestration.*
- 04/11/2011 University of Minnesota, Department of Applied Economics, Title: *Putting CO₂ to work – Turning an environmental liability into a commodity that makes money.*

- 02/18/2011 University of Nebraska – Lincoln, Title: *Increasing geothermal heat extraction efficiency through CO₂ sequestration.*
- 10/20/2010 University of Minnesota, Institute on the Environment (IonE), Frontiers in the Environment Series, Title: *CO₂ – Use it or Lose it!*
- 10/18/2010 Royal Norwegian Embassy, Washington DC, Transatlantic Science Week, Title: *Carbon Capture and Storage and Clean Energy.*
- 10/07/2010 University of Minnesota, Department of Geology and Geophysics, Title: *The fluid- and thermodynamics of combining CO₂ sequestration with geothermal energy capture.*
- 04/07/2010 Massachusetts Institute of Technology (MIT), Title: *Combining CO₂ sequestration with geothermal energy utilization.*
- 02/17/2010 St. Anthony Falls Laboratory (SAFL), University of Minnesota, Title: *Two birds – one stone: Reducing CO₂ emissions from fossil-fuel-based power plants while producing geothermal electricity.*
- 12/13/2009 Hubbert Quorum, USGS-Menlo Park, Title: *Can CO₂ sequestration and geothermal energy utilization be combined?*
- 12/04/2009 University of Wisconsin – Madison, Title: *Can CO₂ sequestration and geothermal energy utilization be combined?*
- 11/17/2009 Initiative for Renewable Energy and the Environment (IREE) annual conference. Title: *Can CO₂ sequestration and geothermal energy utilization be combined?*
- 11/12/2009 Minnesota Groundwater Association, Title: *Preferred groundwater flow paths in aquifer systems.*
- 10/22/2009 University of British Columbia – Vancouver, Canada, Department of Earth and Ocean Science, Title: *A CO₂-sequestering Geothermal Power Plant.*
- 10/22/2009 University of British Columbia – Vancouver, Canada, Department of Earth and Ocean Science, Title: *A bottom-up approach to fluid mechanics: From bouncing fluid packages to Navier-Stokes, slurry, and reactive flow.*
- 10/18/2009 Geological Society of America (GSA) – Annual Conference – Portland, OR, Title: *Hydraulic parameters and groundwater flow patterns in the Oregon Cascades, determined using numerical models that are constrained by diverse data sets*, Geological Society of America *Abstracts with Programs*, Vol. 41, No. 7, p. 176.
- 03/20/2009 Beloit College, WI: Department of Mathematics and Computer Science, Title: *The mathematics of volcanic eruptions.*
- 02/24/2009 San Francisco State University, Title: *Probing groundwater resources via water-rock interactions: From aquifer deformation and cave formation to magmatic gas flow in water.*
- 02/11/2009 University of Colorado – Boulder, Department of Physics, Title: *Geophysical fluid dynamics in tectonic processes and within volcanoes.*
- 10/17/2008 University of Hawaii – Manoa, Title: *Volcano Hydrology: What we can learn about groundwater flow from its interactions with heat and gases.*
- 07/04/2008 Karlsruhe University, Germany, Title: *Coupled heat and stress transfer in geothermal fluid-rock systems.*
- 04/24/2008 Rice University, Title: *The rheology and permeability of magma in volcanic conduits: Implications for eruption dynamics*
- 04/04/2008 University of Wisconsin – Madison, Title: *Lattice-Boltzmann simulations of speleogenic processes and groundwater flow through karst.*
- 03/24/2008 Geological Society of Minnesota, Title: *The role of fluids in Geology.*
- 02/20/2008 North Dakota State University, Department of Geosciences and Department of Physics, Title: *Modeling geophysical fluid dynamics to study the flow of magma and other strange fluids.*
- 02/01/2008 University of Minnesota, Dept. of Aerospace Engineering and Mechanics, Title: *Modeling geophysical fluid dynamics to study the flow of magma and other strange slurries.*
- 11/27/2007 University of Minnesota, Initiative for Renewable Energy and the Environment (IREE - www.umn.edu/iree) conference, Title: *Geothermal Energy.*
- 11/07/2007 University of Arizona, Dept. of Hydrology and Water Resources, Title: *Effects of small-scale processes on large-scale fluid flow patterns and tracers.*

- 10/17/2007 Minnesota Geological Survey, Title: *Current Research in the Hydrogeology and Geofluids Group: From Small to Large Scale Fluid Flow Modeling.*
- 03/23/2007 University of Minnesota, Department of Water Resources Sciences Title: *Aquifers as selective filters for natural groundwater flow tracers.*
- 03/20/2007 HC-Itasca Company (FLAC), Minneapolis, Title: *Subsurface Fluid Dynamics: from magmatic volatile degassing to groundwater flow.*
- 02/16/2007 University of Minnesota - Twin Cities, Department of Civil Engineering, Title: *Interactions of magmatic/mantle volatile degassing with deep groundwater flow.*
- 02/07/2007 Ludwig-Maximilian's Univ., Munich, Dept. of Earth and Env. Sci., Title: *Subsurface Fluid Dynamics: From magmatic volatile degassing to groundwater flow.*
- 11/18/2005 Minnesota Groundwater Association (MGWA) Fall Conference Title: *Helium isotopes as natural tracers in volcanic and non-volcanic aquifers.*
- 05/19/2005 GSA North-Central conference, Minneapolis, MN: Symposium #3: Title: *Effective large-scale permeability of multiple geologic units.*
- 05/04/2005 University of Minnesota, St. Anthony Falls Lab.; Title: *Using spring water measurements of noble gases and heat as tracers of groundwater flow.*
- 04/13/2005 University of Colorado-Boulder, Department of Geological Sciences, Title: *Heat and helium as natural tracers of groundwater flow in volcanoes.*
- 10/07/2004 University of Windsor, Ontario, Canada, Department of Earth Sciences, Title: *Groundwater, heat, and noble gas transfer in volcanic systems.*
- 11/21/2003 Ludwig-Maximilian's University, Munich, Department of Earth and Environmental Science, Title: *Large-scale groundwater flow in the volcanic Oregon Cascades inferred from coupled heat and water transfer modeling and hydroseismic constraints.*
- 04/03/2003 University of Notre Dame, Department of Civil Engineering and Geological Sciences, Title: *Water, Heat, and Earthquakes: Hydrogeology of the Cascades.*
- 03/27/2003 Princeton University, Department of Geosciences, Title: *Water, Heat, and Earthquakes: Hydrogeology of the Cascades.*
- 03/24/2003 University of Minnesota - Twin Cities, Department of Geology and Geophysics, Title (talk 1): *Water, Heat, and Earthquakes: Hydrogeology of the Cascades.*, Title (talk 2): *Fluid Mechanics in Geology.*
- 03/18/2003 University of Michigan, Department of Geological Sciences, Title: *Hydrogeology in the Cascades inferred from thermal and seismic constraints.*
- 03/04/2003 USGS Menlo Park, 2002-2003 Volcano Hazards Team Seminar Series, Title: *Groundwater recharge induced seismicity, heat, and groundwater flow at Mt. Hood, Oregon.*
- 01/29/2003 University of Wisconsin - Eau Claire, Dept. of Geology, Title: *Groundwater flow in the Cascades inferred from coupled heat and water transfer modeling.*
- 11/25/2002 Central Michigan Univ., Dept. of Geology, Title: *Can rain cause earthquakes?*

RESEARCH GRANTS

Overview: The following list does not include endowment funds for the Gibson Chair or from the Werner Siemens Foundation. All amounts listed are for the Principal Investigator (PI) and all co-PIs, i.e., amounts are not reduced just for Saar. (Co-)PIs are listed in the detailed description of the grants below.

\$ 408,301	External (NSF) grant (2014) with Saar as co-PI
\$ 196,000	External (LCCMR) grant (2014) with Saar as PI
\$ 300,000	External (LCCMR) grant (2014) with Saar as co-PI
\$ 1,900,000	External (NSF) grant received (2012) with Saar as PI
\$ 936,753	Internal (UMN) grant received (2012) with Saar as co-PI
\$ 1,550,018	External (DOE) grant received (2010) with Saar as PI
\$ 387,504	Internal (UMN) cost-share (2010) for DOE grant with Saar as PI
\$ 604,060	External (NSF) grant received (2009) with Saar as PI
\$ 350,000	External (NSF) grant received (2009) with Saar as co-PI
\$ 600,000	Internal (UMN-IREE) grant received (2009) with Saar as PI
\$ 97,500	Internal (UMN) grant received (2009) with Saar as PI
\$ 272,922	External (NSF) grant received (2007) with Saar as PI
\$ 291,456	External (NSF) grant received (2005) with Saar as PI
\$ 49,724	Various small UMN-internal and MN-state grants received
\$ 7,944,238	Total amount received since faculty appointment at UMN in 2005 (Total external funds received as PI since 2005: \$5,164,456)

Active Grants:

- 2014-present U.S. National Science Foundation (NSF) OCE Proposal: (PI: Bill Seyfried, **co-PI: Martin Saar**): Title: "In-situ X-ray Tomography and Chemical Tracer Experiments Examining Hydrothermal Alteration of Peridotite: Pore Scale Studies with Implications for Water-Rock Interaction Models", \$408,301, Start/End dates: 07/15/2014 – 07/14/2017 (3 years)
- 2014-present LCCMR (**PI: Martin Saar**, co-PIs: Jimmy Randolph, Scott Alexander): Title: "Innovative Groundwater-Enhanced Geothermal Heat Pump Study", \$196,000, Start/End dates: 07/01/2014-06/30/2016 (2 years).
- 2014-present LCCMR (PI: Scott Alexander, Co-PIs: **Martin Saar**, John Gulliver (UMN Civ. Eng.), Scott McCord (UM Energy Management), Nirml Jain (UM Energy Management), Cathy Abene (UM Energy Management): Title: "Rain Water Reuse and Valuation Investigation", \$300,000, Start/End dates: 07/01/2014-06/30/2016 (2 years).
- 2012-present NSF Sustainable Energy Pathways (SEP) (**PI: Martin Saar** (Earth Sciences), co-PIs: Thomas Kuehn (Mechanical Engineering), Jeff Bielicki (Public Policy), Jimmy Randolph (Earth Sciences), Steve Taff (Applied Economics)): Title: "SEP: A Novel Method Using CO2 and Geothermal Resources for Sustainable Energy Production and Storage" \$1,900,000, Start/End dates: 09/15/2012-09/14/2016 (4 years).

Concluded Grants:

- 2009-2015 IREE (Initiative for Renewable Energy and the Environment) at the University of Minnesota: (**PI: Martin Saar** (Geology & Geophysics, UMN); co-PIs: Thomas Kuehn (Mechanical Engineering, UMN), Karsten Pruess (Lawrence-Berkeley National Lab (LBNL)), Stefan Finsterle (LBNL), Elizabeth Wilson (Humphrey Institute of Public Affairs, UMN), Steven Taff (Applied Economics, UMN), William Gosnold (Geology, Univ. of North Dakota

(UND)), Zheng-Wen Zheng (Geology, UND), Harvey Thorleifson (Minnesota Geological Survey, UMN)), Title: “Combining geothermal energy extraction and CO₂ sequestration to produce clean, renewable, carbon negative electricity.” : **\$600,000** (no overhead), Start/End Dates: 06/01/2009 – 06/30/2015.

- 2010-2014 U.S. Department of Energy (DOE) (PI: Martin Saar, co PIs: William E. Seyfried Jr., Ellen Longmire): Title: “An integrated experimental and numerical study: Developing a reaction transport model that couples chemical reactions of mineral dissolution/precipitation with spatial and temporal flow variations in CO₂/brine/rock systems,” DOE portion (80%) + UMN portion (20%): \$1,550,018 + \$387,504 = **\$1,937,522**, Start/End dates: 02/01/2010-12/31/2014.
- 2012-2014 University of Minnesota – Office of the Vice President for Research (OVPR): Infrastructure Investment Initiative (PI: Donna Whitney (Earth Sciences), co-PIs: **Martin Saar** (Earth Sciences), Kieran McNulty (Anthropology), John Bischof (Mechanical Engineering), Brandy Toner (Soil, Water & Climate), Emi Ito (Earth Sciences)): Title: “Acquisition of a Multi-source X-ray Computed Tomography System” **\$936,753** (\$582,969 from OVPR, \$353,784 matching funds of which \$20,000 from Saar which is the highest match.) Start/End dates: 2011/12-2014/11 (3 years); then self-sustained.
- 2009-2014 NSF-CDI: (**PI: Martin Saar**; co-PI: David Lilja): Title: “CDI-Type 1: A science and engineering programming and inverse modeling environment for massively parallel heterogeneous computing systems”, **\$604,060** for 5 years, Start/End dates: 10/01/2009-09/30/2014
- 2009-2012 NSF grant EAR-0838541 (PI: Christian Teyssier, **Co-PI: Martin Saar**): Title: “Field and numerical analyses of the thermal, mechanical, and fluid evolution of extensional detachment zones”, **\$350,000**, Start/End Dates: 03/01/09 – 02/28/12.
- 2009-2011 McKnight Land-Grant Professor and Chair: Grant amount: **\$97,500**
- 2007-2010 NSF Grant DMS-0724560 (**PI: Martin Saar**; Co-PI: Stuart Walsh); Division of Mathematical Sciences (DMS): Title: “Multiscale multiphase flow simulations of dense vesicular particle suspensions.” Grant Amount: **\$272,922**; Start/End Dates: 09/15/07 – 08/31/10.
- 2007-2008 MN Department of Natural Resources, Carbon Sequestration Study (preliminary numerical modeling work), Grant Amount: **\$6000**; Start/End Dates: 10/12/07 – 06/30/08.
- 2006-2007 UMN Grant-in-Aid for junior faculty members: Title: “Developing a hydrogeologic computer model for the Bemidji, MN oil spill site.” Grant Amount: **\$33,524**; Start/End Dates: 01/01/06 – 06/30/07.
- 2005-2010 NSF Grant EAR-0510723 (**PI: Martin Saar**), Project Title: “Determining large-scale permeability of magma from its bubble and crystal microstructure – a multiphase percolation theory approach.” Grant amount: **\$291,456**; Start/End Dates: 08/01/05 - 07/31/10 (5 years)
- 2005-2008 several 1-semester Undergraduate Research Opportunity (UROP) grants for undergraduate students in the Geofluids Group: Abbey Duncan, Project Title: Computer simulation of a physical groundwater flow model for the Science Museum, investigating surface groundwater interactions, \$1700, 01/01/06 – 05/15/06; Julian d’Andrea, Project Title: Computer modeling of near surface contaminant transport and fate in a simple groundwater system, utilizing the

USGS MODFLOW software package, \$1700, 01/01/06 – 05/15/06; Karli Anderson, Project Title: Analysis of bubble networks using spatial correlation functions, \$1700, 01/10/07 – 05/10/2007; Ryan O’Grady; Project Title: Improving pumping test analyses by including a well efficiency term, \$1700, fall semester 2007; Karli Anderson, \$1700, spring 2008; Lillian Gorman, \$1700, spring 2008; total: **\$10,200** (no overhead).

PEDAGOGY TRAINING AND FACULTY DEVELOPMENT

- 2010 Andy Goodman Communications Workshop, provided through the Institute on the Environment (IonE) at UMN.
- 2010 Aldo Leopold Leadership Program (<http://leopoldleadership.stanford.edu>), Woods Institute for the Environment, Stanford University, held at the Institute on the Environment (IonE) at the University of Minnesota, August 23-27, 2010.
- 2005-2006 UMN faculty Early Career Teaching Program 2005-2006, Monthly teaching seminars over the course of an academic year covering topics such as teaching with technology, collaborative learning, teaching large classes, ...
- 2005 NSF on-the-cutting edge workshop: “Early Career Faculty Workshop: Teaching, Research, and Managing Your Career” (June 8-13, 2005)
- 2000 Using Technology in the Classroom (seminar at the University of Oregon)
- 1999 College Science Teaching (term-long course at the University of Oregon)
- 1999 Teaching Large Classes (seminar at the University of Oregon)

COURSES TAUGHT (past, current, and upcoming)

Some teaching evaluations are available at: <http://www.geo.umn.edu/orgs/geofluids>

More teaching information is provided in the Statement of Teaching document. In the following:

ETHZ=Swiss Federal Institute of Technology – Zurich, UMN=University of Minnesota (as faculty member), UO=University of Oregon (as graduate student), ESCI=Dept. of Earth Sciences, GEO=Dept. of Geology and Geophysics (former department name). Several courses co-developed: General Hydrogeology, Fluid Earth Dynamics, Hydrogeology Field Camp. Main course development: Fluid Mechanics in Earth and Environmental Sciences.

- 2015 ETHZ Geothermal Energy (1/2 semester)
- 2015 ETHZ Groundwater
- 2015 ETHZ Joint Applied Geophysics Masters Course II (co-taught)
- 2015 ETHZ Joint Applied Geophysics Masters Course I (co-taught)
- move to ETH Zurich (ETHZ) -----
- 2014 UMN ESCI 5205: Fluid Mechanics in Earth and Environmental Sciences
- 2014 UMN ESCI 4971W / 5971: Hydrogeology Field Camp
- 2013 UMN ESCI 4971W / 5971: Hydrogeology Field Camp
- 2013 UMN ESCI 4702 (formerly 5701): General Hydrogeology
- 2012 UMN ESCI 3203: Fluid Earth Dynamics
- 2012 UMN ESCI 4971W / 5971: Hydrogeology Field Camp
- 2012 UMN ESCI 4702: (formerly 5701): General Hydrogeology
- 2011 UMN ESCI 5205: Fluid Mechanics in Earth and Environmental Sciences
- 2011 UMN ESCI 3203: Fluid Earth Dynamics
- 2011 UMN ESCI 4971W / 5971: Hydrogeology Field Camp
- Department Name ID changed from GEO to ESCI -----
- 2011 UMN GEO 4702 (formerly 5701): General Hydrogeology
- 2010 UMN GEO 3203: Geodynamics II - The Fluid Earth

2010	UMN GEO 4971W / 5971: Hydrogeology Field Camp
2010	UMN GEO 4702 (formerly 5701): General Hydrogeology
2009	UMN GEO 5205: Fluid Mechanics in Earth and Environmental Sciences
2009	UMN GEO 3203: Geodynamics II - The Fluid Earth
2009	UMN GEO 4971W / 5971: Hydrogeology Field Camp
2009	UMN GEO 4702 (formerly 5701): General Hydrogeology
2008	UMN GEO 3203: Geodynamics II - The Fluid Earth
2008	UMN GEO 4971W / 5971: Hydrogeology Field Camp
2008	UMN GEO 5701: General Hydrogeology
2008	UMN GEO 8980: Seminar: Volcanology
2007	UMN GEO 5205: Fluid Mechanics in Earth and Environmental Sciences
2007	UMN GEO 3203: Geodynamics II - The Fluid Earth
2007	UMN GEO 4971W / 5971: Hydrogeology Field Camp
2006	UMN GEO 3203: Geodynamics II - The Fluid Earth
2006	UMN GEO 5701: General Hydrogeology
2006	UMN GEO 4971: Hydrogeology Field Camp
2006	UMN GEO 1001: Earth and Its Environments (~160 students)
2005	UMN GEO 5701: General Hydrogeology
2005	UMN GEO 4971: Hydrogeology Field Camp
2005	UMN GEO 4010/8980: Coupled Heat and Fluid Flow in the Earth's Crust
2001	UO Taught an introduction to geology course
2001	UO Taught an advanced hydrogeology undergraduate course
1997-1999	UO Teaching Assistant (TA) for: Hydrogeology, Geophysics, Geological Fluid Mechanics

SERVICE, OUTREACH, SOFTWARE DEVELOPMENT, AND COMMERCIALIZATION

Service and Outreach:

2015	Co-Editor of the journal: Geothermal Energy (Springer)
2013	Outreach: Guest lecture in the field on volcano-hydrology and hot springs at Lassen Volcanic National Park contributing to NASA Ames' public outreach program with Red Bluff, California, High School students.
2012-2013	Committees: 1) Undergraduate Studies, 2) Field Camp, 3) Computer, 4) Building
2011	In the News: Several general public articles following a UMN press release on the CO ₂ -based Geothermal energy extraction technology we developed such as: Huffington Post: "Geothermal Technology Offers Path To Curbing CO ₂ Emissions, Global Warming", Discovery News: "Greenhouse gas pumped to boost clean energy", Ars Technica "We might harvest the Earth's heat while trapping carbon emissions", Imperial College's student newspaper, Felix: "Using carbon dioxide to fight warming", and Smart Planet "A new geothermal technique packs a one-two punch".
2010-2014	Associate Editor of Hydrogeology Journal (Official Journal of the International Association of Hydrogeologists - IAH)
12/29/2009	In the News: Discovery News article on geothermal energy research: news.discovery.com/earth/carbon-dioxide-capture-geothermal-green-energy.html
11/17/2009	Outreach: Talk at the Initiative for Renewable Energy and the Environment (IREE) annual conference. Title: Can CO ₂ sequestration and geothermal energy utilization be combined? (see also: invited talks)
11/16/2009	In the News: MIT Technology Review: Saar et al. receive \$1.5M from DOE for geothermal energy research: www.technologyreview.com/energy/23953
11/12/2009	Outreach: Talk at the Minnesota Groundwater Association on preferred groundwater flow paths in aquifer systems. (see also invited talks)
11/04/2009	In the News: MinnPost.com article on Saar's geothermal energy funding:

- www.minnpost.com/markneuzil/2009/11/04/13144/geothermal_grants_heat_up_in_minnesota
- 09/29/2009 **Outreach:** Presentation to the Legislative-Citizen Commission on Minnesota Resources (LCCMR) on combining CO₂ sequestration with geothermal energy utilization in Minnesota: Utilizing low geothermal heat flow regions for geothermal electricity generation.
- 11/14/2008 **Outreach: Guest lecture** on the use of calculus in the geosciences, Department of Mathematics and Computer Science, Beloit College, Beloit, WI.
- 10/3-5/2008 **Outreach: Taught a three-day pumping test workshop** for hydrogeology professionals at the Hydrocamp Field Site in north-central Minnesota.
- 03/24/2008 **Outreach: Talk for the general public:** Geological Society of Minnesota, Title: The role of fluids in Geology. (see also invited talks)
- 03/12/2008 **Outreach: Guest lecture** on pumping test analyses, Geology Department, Macalester College, Saint Paul, MN
- 2007 **Session Chair**, AGU fall conference, San Francisco, Title: “Dynamics of Gas Transport in Magma I+II” (oral session)
- 2007 **Participant in Workshop:** “Connecting Geoscience Departments to the Future of Science: New Structures for Research and Curriculum.” Held at Carleton College, MN
- 2007 Served on **departmental committees:** 1) tectonics search for 2007/2008 position, 2) student fellowships and awards
- 2006-2010 Serving on **departmental committees:** 1) strategic hiring plan, 2) undergraduate studies, 3) field camp, 4) computer, 5) awards
- 2006 Served on **departmental committees:** tectonics search for 2006/2007 position
- 2006 **In the News:** Served as expert geoscientist for a **documentary film** by German National TV (Focus TV on channel Pro-7) at Yellowstone National Park (3 days in May). Documentary was shown on national German TV following the docudrama “Supervolcano”.
- 2005 **Session Chair**, GSA Conference, Salt Lake City, Title: “Tribute to Hans-Olaf Pfannkuch: From Darcy to the Modern World of Environmental and Contaminant Hydrogeology”
- 2005 **Invited Department of Energy (DOE) research proposal reviewer and panel member** for proposals addressing dense-non-aqueous-phase liquid (**DNAPL**) cleanup (from previous underground storage/spilling by power plant operations) and related up-scaling of simulations and lab experiments to the field scale.
- 2005 **Session Chair**, AGU Conference, New Orleans, Title: “Volcano Hydrology”
- 2005 **Co-organizer of symposium** entitled: "Groundwater sustainability: methods for analysis, mapping, monitoring, and management of regional systems", GSA North-Central conference.
- 2005 Community Campaign Fund Drive organizer for the Department of Geology and Geophysics to motivate colleagues to contribute to the university's donations for the community.
- 2003 **Co-leader** of 3-day GSA field trip: "Hydrogeology of Cascade Range Volcanoes: Mount St. Helens, Mount Hood, and Central Oregon"
- 2003-present **National Science Foundation (NSF) proposal reviews** (2 to 7 per year).
- 2003-present **Journal publication reviews** (~15 per year) for: Journal of Geophysical Research (Solid Earth, Earth Surface), Earth and Planetary Science Letters, Geophysical Research Letters, Water Resources Research, Geophysical Journal International, Journal of Volcanology and Geothermal Research, Seismological Research Letters, Geochemical Journal, Hydrogeology J.
- 2002 **Session Chair**, AGU conference, San Francisco, Title: “Geophysical Constraints on the Role of Fluids in the Crust”

Software Development: LBHydra

Aside from scripts and short codes (e.g., DBCreate – see publications: Kong, Tutolo, and Saar, 2013), software development includes a major percolation theoretical code and a numerical multiphase-multicomponent lattice-Boltzmann (LB) fluid flow simulator entitled LBHydra which is an object-oriented C++ and Python based code. LBHydra is capable of simulating reactive flow over a wide range of spatial and temporal scales and is freely available to the scientific and engineering communities (**LBHydra.umn.edu**). Traditionally, LB codes have only been capable of simulating detailed small-scale flow. A particularly new development

included in this simulator is its capability to also simulate large-scale fluid flow employing a so-called partial-bounceback approach (see also publications: Walsh, Burwinkle, and Saar, 2009). LBHydra can be run in parallel on multiple processors including on multiple CUDA-compliant Graphics Processing Units (GPUs), a development enabled through extensive collaboration between Saar's and David Lilja's (Department Chair of Electrical and Computer Engineering) NSF-funded research groups, resulting in speed-ups by up-to a factor of 40 per GPU. Multiple GPUs can be combined. A more detailed description, licensing information, a manual with tutorials, funding resource information, and a list of publications that have utilized LBHydra to date, can be found at: LBHydra.umn.edu

Commercialization: CO₂-Plume Geothermal (CPG) system technology

In 2011, the Office for Technology Commercialization (OTC) at the University of Minnesota submitted international patent applications on behalf of the inventors of the CO₂-Plume Geothermal (CPG) system technology, Martin O. Saar, Jimmy B. Randolph (Ph.D. student of Martin Saar at the time), and Thomas H. Kuehn (Professor in Mechanical Engineering) entitled Carbon dioxide-based geothermal energy generation systems and methods related thereto, patent application numbers 13/202,746 (US), 10751138.8 (EP), 2010022305 (Australia), 2753393 (Canada). The U.S. patent (No. 8,316,955) was accepted and issued on November 27, 2012, and the Canada Patent was accepted and issued on Sep. 3, 2013. In addition, we submitted a patent on CPG with enhanced oil recovery (EOR), i.e., CPG-EOR in the US and several countries. These patents are pending plus continuation patents have been submitted. In addition, Heat Mining Company LLC, has been founded as a University of Minnesota startup company, with Saar as co-founder and Chief Scientific Officer, and has acquired the CPG patent license to commercialize the CPG technology. In the summer and fall of 2014, Saar has co-founded, and serves as Chief Scientific Office of, TerraCOH Inc., a COH-geothermal company. Heat Mining Company LLC is an investor in TerraCOH Inc. and all patent licenses have been transferred from Heat Mining Company LLC to TerraCOH Inc. **All potential conflicts of interest are being handled by the University of Minnesota in accordance with its conflict of interest policies** and, where appropriate, notification of this has been included in publications and funding proposals. In addition, advisees have been made aware of this situation and been given a contact person in case of concerns.