

Tobias Keller

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PERSONAL STATEMENT

I am a **Computational Geoscientist** interested in the **physical and chemical processes** governing **volcanoes and their deep magmatic roots**. My interests span magmatic differentiation during **planetary formation, magmatism and igneous rock formation** in the crust and lithosphere in diverse tectonic settings, and near-surface **volcanic, hydrothermal and ore formation** processes. My main research tools are custom-built **computational models of multi-phase reactive transport** complemented by **machine learning techniques** relating model outcomes to **observational and experimental evidence** from **geochemistry and petrology, geology and geophysics, volcano monitoring and resource exploration**.

APPOINTMENTS

- Sept 2019 – present** – **Lecturer (Assistant Professor) in Computational Geosciences**, Geographical & Earth Sciences, University of Glasgow.
- Jan 2018 – July 2019** – **Advanced Postdoc.Mobility Fellow SNSF**, Geophysics, Stanford University.
 Physics of three-phase flow in volcanic systems. Mentor: Jenny Suckale.
- Sept 2016 – Jan 2018** – **Postdoctoral Research Associate**, Geophysics, Stanford University.
 Physics of three-phase flow in volcanic systems. Mentor: Jenny Suckale.
- Sept 2013 – Aug 2016** – **Postdoctoral Research Associate**, Earth Sciences, University of Oxford.
 Role of volatiles in mid-ocean ridge magmatism. Mentor: Richard F Katz.
- May 2009 – Apr 2013** – **Graduate Research Assistant**, Geophysics, ETH Zürich.
 Melt transport in lithosphere and crust. Advisors: Paul J Tackley, Boris J P Kaus.
- March 2007 – April 2008** – **Undergraduate Research Assistant**, Geophysics, ETH Zürich.
 Magmatism and crust formation coupled to mantle convection on Mars. Advisor: Paul J Tackley.

EDUCATION

- May 2009 – April 2013** – **PhD in Sciences ETH**, Geophysics, ETH Zürich. Advisors: Paul J Tackley & Boris J P Kaus.
Numerical modelling of magma dynamics interacting with tectonic deformation of the lithosphere and crust. Defended April 19th 2013, conferred September 2014.
- Sept 2006 – April 2009** – **MSc (Magna Cum Laude)**, Geophysics, ETH Zürich. Advisor: Paul J Tackley.
Towards self-consistent modelling of the Martian dichotomy: the influence of one-ridge convection on crustal thickness distribution (peer-reviewed publication, *Icarus*).
- Sept 2003 – Aug 2006** – **BSc (Cum Laude)**, Earth Sciences, ETH Zürich. Advisor: Paul J Tackley.
Numerical modelling of the thermo-chemical evolution of the Martian mantle.

AWARDS & RECOGNITIONS

- May 2020** – **Outstanding Early Career Scientist Award**, EGU Geodynamics Division, for “*outstanding scientific contributions related to understanding magma dynamics and igneous systems in the mantle and lithosphere*”.

- June 2019** **Certificate of Achievement in Mentoring**, School of Earth, Energy & Environmental Sciences, Stanford University.
- June 2018** **2017 Editors' Citation for Excellence in Refereeing**, *Geochemistry, Geophysics, Geosystems*
- Aug 2016, March 2017** **Featured Articles** in *Deep Carbon Observatory Newsletter* reporting on 2016 paper in *Journal of Petrology* on volatile-driven melt channeling in the asthenosphere, and 2017 paper in *Earth and Planetary Science Letters* on volatiles beneath mid-ocean ridges.
- Nov 2013** **Student Author Award** by *Geophysical Journal International* for my 2013 paper on melt transport coupled to tectonics of the lithosphere and crust.
- Aug 2009** **Front Page Illustration** in *Icarus* featuring visualisations from my 2009 paper of three-dimensional models of the formation of the Martian crustal dichotomy.

 FUNDING

- May 2019** **Marie Curie Postdoc Fellowship**, *European Research Council*, as P.I., candidate Ying-Qi Wong, 2 years, £325k.
- Feb 2018** **Grant W911NF-18-1-0092**, *US Army Research Office*, as co-author (20% contribution), P.I. Jenny Suckale, and Zhipeng Qin, 3 years, \$367k.
- Dec 2017** **Advanced Postdoc.Mobility Fellowship 177816**, *Swiss National Science Foundation*, as P.I., 18 months, \$80k.

 PUBLICATIONS (440 CITATIONS, H-INDEX 9)
under review

- 2020** Culha C, **Keller T**, & Suckale J. Evolution of thermal crystal zonations and their heterogeneity in crystal populations during magma cooling. *J Geophys Res: Solid Earth*, under review.
- 2020** **Keller T**, Tornos F, Hanchar J, Pietruszka D, Graham N, & Severin K. Extrusion of iron-rich melt formed magnetite-apatite deposits on El Laco volcano. *Nature Comms*, under review.

peer-reviewed

- 2020** Culha C, Suckale J, **Keller T**, & Qin Z. Crystal fractionation by crystal-driven convection. *Geophys Res Letts*, 47. doi:10.1029/2019GL086784
- 2020** Birnbaum J, **Keller T**, Lev E, & Suckale J. Periodic outgassing as a result of unsteady convection in Ray lava lake, Mount Erebus, Antarctica. *Earth Planet Sci Letts*, 530. doi:10.1016/j.epsl.2019.115903.
- 2019** **Keller T** & Suckale J. A continuum model of multi-phase reactive transport in igneous systems. *Geophys J Inter*, 219, 185-222. doi:10.1093/gji/ggz287.
- Lichtenberg T, **Keller T**, Katz R F, Golabek G J, & Gerya T V. Magma ascent in planetesimals controlled by grain size. *Earth Planet Sci Letts*, 507, 154–165. doi:10.1016/j.epsl.2018.11.034.
- 2018** J Suckale, Z Qin, D Picchi, **T Keller**, & I Battiato: Bistability of buoyancy-driven exchange flows in vertical tubes. *J Fluid Mech*, 850, 525–550. doi: 10.1017/jfm.2018.382.
- 2017** A Turner, R F Katz, M D Behn, & **T Keller**: Magmatic focusing to mid-ocean ridges: the role of grain-size variability and non-Newtonian viscosity. *Geochem Geophys Geosyst*, 18, 4342–4355. doi: 10.1002/2017GC007048.
- **T Keller**, R F Katz, & M M Hirschmann: Volatiles beneath mid-ocean ridges: Deep melting, channelised transport, focusing, and metasomatism. *Earth Planet Sci Lett*, 464, 55–68. doi: 10.1016/j.epsl.2017.02.006.
- 2016** J Suckale, **T Keller**, K V Cashman, & P-O Persson: Flow-to-fracture transition in a volcanic mush plug may govern normal eruptions at Stromboli. *Geophys Res Lett*, 43, 12071–12081. doi: 10.1002/2016GL071501.

- H Rawson, **T Keller**, K Fontijn, D M Pyle, T A Mather, V C Smith, & J A Naranjo: Compositional variability in mafic arc magmas over short spatial and temporal scales: Evidence for the signature of mantle reactive melt channels. *Earth Planet Sci Lett*, 456, 66–77. doi: [10.1016/j.epsl.2016.09.056](https://doi.org/10.1016/j.epsl.2016.09.056).
- **T Keller** & R F Katz: The role of volatiles in reactive melt transport in the asthenosphere. *J Petrol*, 57, 1073–1108. doi: [10.1093/petrology/egw030](https://doi.org/10.1093/petrology/egw030).
- 2013** **T Keller**, D A May, & B J P Kaus: Numerical modelling of magma dynamics interacting with tectonic deformation of lithosphere and crust. *Geophys J Int*, 195, 1406–1442. doi: [10.1093/gji/ggt306](https://doi.org/10.1093/gji/ggt306).
- 2011** G J Golabek, **T Keller**, T V Gerya, G Zhu, P J Tackley, & J A D Connolly: Origin of the martian dichotomy and Tharsis from a giant impact causing massive magmatism. *Icarus*, 215, 346–357. doi: [10.1016/j.icarus.2011.06.012](https://doi.org/10.1016/j.icarus.2011.06.012).
- 2009** **T Keller** & P J Tackley: Towards self-consistent modelling of the Martian dichotomy: The influence of one-ridge convection on crustal thickness distribution. *Icarus*, 202, 429–443. doi: [10.1016/j.icarus.2009.03.029](https://doi.org/10.1016/j.icarus.2009.03.029).

 SPEAKING INVITATIONS

- 2020** **Invited Talk:** Goldschmidt Conference, Hawaii.
- **Invited Seminars:** Durham University; CEED Institute, University of Oslo; University of Oxford; BGI Institute, University of Bayreuth.
- 2019** **Keynote Lecture,** Fluid Migration in Subduction Zones Workshop, Minneapolis.
- **Invited Seminars:** UC San Diego; Macquarie University, Sydney; University of Sydney; University of Oxford; Imperial College London.
- 2018** **Invited Talks:** AGU Fall Meeting, Washington D.C.; BHP Copper Porphyry Workshop, University of Bristol.
- **Invited Seminars:** Caltech, Pasadena; ETH Zürich; University of California, Berkeley; San Jose State University.
- 2017** **Invited Talks:** AGU Fall Meeting (2x), New Orleans.
- **Invited Seminars:** University of California, Santa Cruz; Yale University, New Haven; University of Bristol.
- 2016** **Invited Talk:** AGU Fall Meeting, San Francisco.
- **Invited Seminars:** Lamont-Doherty Earth Observatory, New York; Memorial University, St. John's.
- **Keynote Lecture:** Melt in the Mantle program, Newton Institute, Cambridge.
- 2015** **Invited Talks:** AGU Fall Meeting, San Francisco; EGU General Assembly, Vienna; SIAM Computational Science & Engineering, Salt Lake City; DCO Thematic Institute, UC Berkeley.
- **Invited Seminar:** Stanford University; ETH Zürich; J Gutenberg University, Mainz.
- 2014** **Keynote Lecture:** CIG/CGU Mantle/Lithosphere Dynamics Workshop, Banff.
- **Invited Talks:** EGU General Assembly (2x), Vienna.
- **Invited Seminar:** Physics of Earthquakes and Volcanos, GFZ Potsdam.
- 2013** **Invited Seminar:** Geophysics, University of Cambridge.
- 2012** **Invited Seminar:** Geodynamics, University of Oxford.
- **Keynote Lecture:** 4D Adamello Conference, Bagolino.
- 2011** **Keynote Lecture:** European Mars Convention, Neuchâtel.
- 2009** **Invited Talk.** European Planetary Science Congress, Potsdam.

MENTORING & SUPERVISION

- Nov 2020 – present** – **Ying-Qi Wong**, Marie Curie Postdoctoral Fellow. Geographical & Earth Sciences, University of Glasgow.
- Oct 2020 – present** – **Fakhri Bintang**, Ph.D. Candidate, Geographical & Earth Sciences, University of Glasgow. *Masters of disguise: can chondrite parent bodies hide beneath a chondritic cover?*
- Oct 2020 – present** – **Velveth Perez**, Ph.D. Candidate, Geographical & Earth Sciences, University of Glasgow. *Volcanic processes and hazard assessment of Torfajökull volcano and surrounding areas.*
- Jan 2020 – present** – **Gary Mullen**, Ph.D. Candidate, Geographical & Earth Sciences, University of Glasgow. *Modelling hydrothermal mineralisation by reactive transport in fractured rock.*
- Jun 2017 – present** – **Cansu Culha**, Ph.D. Candidate, Geophysics, Stanford University. *Multi-phase flow in magma chambers.* Supervisor: Jenny Suckale.
- Sept 2017 – May 2018** – **Janine Birnbaum**, B.Sc. Hons. Candidate. Geophysics, Stanford University, awarded Best Student Paper by Geophysics Dept., on to Ph.D. at Columbia University, NY. *Episodic degassing from unsteady lava lake convection in Ray Lava Lake, Mount Erebus, Antarctica.* Co-mentor: Jenny Suckale.
- Jul 2017 – Aug 2017** – **Janine Birnbaum, Jabari Hastings, Liannie Velazquez**, SESUR/SURGE undergraduate summer programmes. Stanford University. *Computational simulations of episodic convection in lava lakes.* Co-mentors: Jenny Suckale, Zhipeng Qin.
- Oct 2016 – May 2017** – **Grace Manley**, BSc Hons Thesis. Earth Sciences, University of Oxford. On to PhD at University of Oxford, UK. *Reactive melt transport in multi-component models of mantle melting.* Co-mentor: Richard F Katz.
- Oct 2015 – May 2016** – **Bethan Gregory**, BSc Hons Thesis. Earth Sciences, University of Oxford. On to PhD at University of St. Andrews, UK. *Model of thermogenic carbon release during the Siberian Traps Large Igneous Province.* Co-mentors: Micha Ruhl, Richard F Katz.

TEACHING

- Lecturer** – **Tectonics, Structural & Metamorphic Geology**, Earth Science Undergraduates (year 2), University of Glasgow.
- **Introduction to Computational Geosciences**, Geology and Environmental Geoscience Undergraduates (year 3), University of Glasgow.
- **Magmatic/-hydrothermal ore deposits**, Geology Honours (year 4), University of Glasgow.
- Lab Leader** – **Statistics & GIS**, undergraduates, University of Glasgow, Autumn 2019.
- Tutor** – **Geodynamics**, undergraduate, Earth Sciences, University of Oxford, Feb–May 2014.
- Guest Lecturer** – **Magma/mantle dynamics**, graduates, University of Oxford, Nov 2015.
- Teaching Assistant** – **Scientific Programming Lab**, NERC Doctoral Training Partnership, University of Oxford. Nov 2014, Oct 2015.
- **Finite-Element Modelling in Geodynamics**, graduates, ETH Zürich, July 2012.
- **Introduction to Geodynamic Modelling**, undergraduates, ETH Zürich, May 2010.

REVIEWING ACTIVITY

- Articles** – *Geochemistry Geophysics Geosystems, Geophysical Journal International, Journal of Petrology, Tectonophysics, International Journal of Earth Sciences, Solid Earth, Elements.*

Proposals *UK Natural & Environmental Research Council, US National Science Foundation, Swiss National Science Foundation, European Research Council, EU.*

FIELD EXPERIENCE

Sept 2017 **Mt Etna & Salinelle, Italy**, volcanology, carbon science, 2 days.
Nov 2016 **Central Volcanic Zone, Chile**, volcanology, mining geology, 1.5 weeks.
Sept 2012 **Adamello, Italy**, igneous petrology, 3 days.
Nov 2011 **Patagonia, Argentina/Chile**, igneous petrology, structural geology, 1.5 weeks.
Sept 2010 **Sierra Nevada, USA**, igneous petrology and volcanology, 1.5 weeks.
June 2010 **Adamello, Italy**, igneous and metamorphic petrology, 1 week.
Aug 2009 **Adamello, Italy**, igneous and metamorphic petrology, 1 week.
Sept 2008 **Eolian Islands & Sicily, Italy**, volcanology, 1 week.

COMPUTING EXPERIENCE

Programming Matlab, C, Python, Fortran, PETSc.

Techniques Finite-element, finite-difference, PDE solvers, particle-in-cell method, Newton method, multigrid.

Open Codes github.com/kellertobs

CONFERENCE SERVICE

2017-2019 **Session Convener**, coupled mechanical/thermodynamic modeling, AGU Fall Meetings.

Aug 2017 **Organising Committee**, 3rd DCO Early Career Workshop, Sicily, IT.

Dec 2011 **Session Convener**, AGU Fall Meeting, San Francisco, CA.

SOCIETY MEMBERSHIPS

American Geophysical Union, European Geosciences Union, Volcanic-Magmatic Study Group UK.

VARIOUS

2017 **Outreach: Bay Area Science Festival**, communicating geology to the public, San Francisco.

2015 **Outreach: Career Day**, Doctoral Training Partnership in Environment. Res., Univ Oxford, UK.

2015 **Training: CIDER summer school**, UC Berkeley, CA.

2010-2013 **Training: Interdisciplinary doctoral school**, ProDoc 4D Adamello, ETH Zürich, CH.

2002-2010 **Community Service: Youth community volunteer**, mentoring young adults, organizing social events, team leadership, planning and executing educational lecture series.

2002-2012 **Military Service: Swiss Air Force Sergeant**, fire and mountain rescue, group leadership, planning and executing training sessions.

Languages **German** (mother tongue), **English** (proficient), French (intermediate), Italian (basic).

Interests Space exploration, future technologies, cooking, traveling, photography, reading, writing.