

JEROME A. NEUFELD

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Research Interests

My research couples thermodynamics and fluid dynamics in multiphase systems within geophysical settings using analytical, numerical and experimental techniques. Current research is focused on the areas of multiphase flows in porous media including carbon sequestration, solidification and melting in magmatic systems and the cryosphere, on elastically dominated fluid flows in tectonic and cryospheric settings, and on the generation of magnetic fields in early solar system planetesimals.

Education

05/2008 Ph.D. Geophysics, Yale University, New Haven, USA
05/2004 M.Phil. Geophysics, Yale University, New Haven, USA
08/2002 M.Sc. Physics, University of Toronto, Toronto, Canada
05/2001 B.A.Sc. Engineering Science Physics, University of Toronto, Toronto, Canada

Professional Experience

10/2011–present University Lecturer
 BP Institute
 Department of Earth Sciences
 Department of Applied Mathematics and Theoretical Physics
 University of Cambridge

10/2011–present Royal Society University Research Fellowship

10/2011–present Official Fellow and Director of Studies in Physics
 St. Catharines College, University of Cambridge

10/2012–present Assistant Director, Cambridge Centre for Carbon Capture and Storage

10/2009–09/2011 Leverhulme Early Career Fellow & Lloyds Tercentenary Fellow
 Dept. Applied Mathematics and Theoretical Physics, University of Cambridge

10/2009–09/2011 Junior Research Fellow
 St. Catharines College, University of Cambridge

08/2007–07/2009 Post-doctoral Research Associate
 Dept. Applied Mathematics and Theoretical Physics, University of Cambridge

Fellowships, Honors and Awards

2009 *Donald L. Turcotte Award*, Awarded by the American Geophysical Union
2007 *Philip M. Orville Prize*, Dept. Geology & Geophysics, Yale University

Projects and Grants

- 05/2016–04/2020 *Migration of CO₂ through North Sea Geological Carbon Storage Sites: Impact of Faults, Geological Heterogeneities and Dissolution*
NERC consortium grant (£2 200 000)
(PI with M. Bickle (Cam), S. Krevor (Imperial), A. Chadwick (BGS), Z. Shipton (Strathclyde))
- 04/2016–10/2019 *Regime change: convection and crystallisation of magma*
NERC (£580 441)
(co-I with M. Holness (PI))
- 04/2015–01/2016 *The formation and evolution of dense monomineralic layers in mafic intrusions*
Newton Trust (£20 601)
(co-I with M. Holness (PI))
- 02/2014–01/2017 *Wellbore strengthening* (£195 041)
Project grant from BP Plc
(co-I with A.W. Woods (PI))
- 02/2016–06/2016 *Melt in the mantle* (£120 000)
Isaac Newton Institute Program
(co-I with J. Rudge (PI), R. Arbogast, A. Deuss, R. Katz)
- 01/2015–12/2015 *Measuring permeability in reactive and poroelastic porous media* (£20 000)
Newton Trust (PI)
- 01/2014–07/2014 *Measuring permeability in reactive porous media (sea ice)* (£31 000)
BAS Innovation centre (PI, with co-I P. Holland, M.G. Worster)
- 09/2013–09/2017 *Magma to ice-cream: the crystallisation of complex fluids* (£71 796)
NERC CASE studentship with Unilever UK (co-I with M. Holness)
- 12/2012–12/2015 *TRUST* (£193 500)
5 year EU CCS consortium grant (co-I with H. Huppert)
- 03/2012–09/2016 *Crystal production rates in high-latitude polynyas* (£103 820)
Royal Society equipment grant (PI)
- 01/2012–06/2012 *Optical imaging of multiphase flows* (£29 800)
EPSRC seed funding (PI)
- 01/2012–12/2014 *PANACEA* (£195 269)
EU CCS consortium grant (PI, with co-I H.E. Huppert)
- 10/2011–09/2016 *Fluid dynamics of multiphase geophysical systems* (£481 596)
Royal Society University Research Fellowship (PI)
- 10/2009-09/2011 *Fluid dynamics of multiphase geophysical systems*
Leverhulme Early Career Fellowship (PI)

Courses taught

- 2015 Fluid Dynamics of the Solid Earth
Part III Mathematical Tripos, DAMTP, University of Cambridge

- 2015 Fluid Dynamics of the Solid Earth (with G. Worster)
Part III Mathematical Tripos, DAMTP, University of Cambridge
- 2015 Oceanic and Continental Margins (with B. White, J. Maclennan, M. Edmonds)
Part II Earth Sciences, University of Cambridge
- 2014 & 2015 Demonstrations in fluid mechanics (8/8 experimental demonstrations)
Part III Mathematical Tripos, DAMTP, University of Cambridge
- 2014 Basin Dynamics (lecture on CO₂ storage) (with N. White)
Part II Earth Sciences, University of Cambridge
- 2012 Fluid dynamics of energy and the environment (with A.W. Woods)
2/6 lectures on CO₂ sequestration and flow in porous media
Fluid Dynamics of Sustainability and the Environment summer school.
- 2012 Fluid dynamics of the environment (with C.-P. Caulfield)
12/24 lectures on buoyancy-driven flows at the graduate level
Part III Mathematical Tripos, DAMTP, University of Cambridge.
- 2012 Advanced topics in fluid mechanics of climate (with J.R. Taylor, P.F. Linden)
6/24 lectures given on buoyancy-driven flows at the graduate level
Part III Mathematical Tripos, DAMTP, University of Cambridge
- 2010 & 2011 Solidification of Fluids (with Prof. M.G. Worster)
13/24 lectures given on the fluid dynamics of solidification at the graduate level
Part III Mathematical Tripos, DAMTP, University of Cambridge

Publications

- [44] M.B. Holness, J.A. Neufeld, A.J. Gilbert, R. Macdonald (sub judice) *Orientation of tabular mafic intrusions controls convective vigour and crystallization style* J. Petrol.
- [43] T.V. Ball, H.E. Huppert, J.R. Lister, J.A. Neufeld (sub judice) *The relaxation time for viscous and porous gravity currents following a change in flux* J. Fluid Mech.
- [42] F. Box, J.A. Neufeld, A.W. Woods (sub judice) *On the dynamics of a thin viscous film spreading between a permeable horizontal plate and an elastic sheet.* J. Fluid Mech.
- [41] M.J. Golding, H.E. Huppert, J.A. Neufeld (sub judice) *Two-phase gravity currents resulting from the release of a fixed volume of fluid in a porous medium.* J. Fluid Mech.
- [40] M. Holness, R. Farr, J.A. Neufeld (2017) *Crystal settling and convection in the Shiant Isles Main Sill.* Contrib. Mineral. Petrol. **172**:7, 1-25.
- [39] H. Cooray, H.E. Huppert, J.A. Neufeld (2016) *Maximal liquid bridges between horizontal cylinders.* Proc. Roy. Soc. A. **472**(2192), 20160233-18.
- [38] L.R. Cowton, J.A. Neufeld, N.J. White, M.J. Bickle, J.C. White, R.A. Chadwick (2016) *An inverse method for estimating layer thickness and volume of a thin CO₂-filled layer at the Sleipner Field, North Sea.* J. Geophys. Res. **121**, 5068–5085.
- [37] R. Sayag, J.A. Neufeld (2016) *Propagation of viscous currents on a porous substrate with finite capillary entry pressure.* J. Fluid Mech. **801**, 65-90.
- [36] D.R. Hewitt, J.P. Nijjer, M.G. Worster, J.A. Neufeld (2016) *Flow-induced compaction of a deformable porous medium.* Phys. Rev. E. **93**, 023116.

- [35] S.S. Pegler, H.E. Huppert, J.A. Neufeld (2016) *Stratified gravity currents in porous media* J. Fluid Mech. **791**, 329–357.
- [34] D.R. Hewitt, J.A. Neufeld, N.J. Balmforth (2015) *Shallow, gravity-driven flow in a poro-elastic layer* J. Fluid Mech. **778**, 335–360.
- [33] S.S. Pegler, E.L. Bain, H.E. Huppert, J.A. Neufeld (2015) *Fluid invasion of an unsaturated leaky porous layer* J. Fluid Mech. **777**, 97–121.
- [32] K.H. Lythgoe, J.F. Rudge, J.A. Neufeld, A. Deuss (2015) *The feasibility of thermal and compositional convection in Earth’s inner core* Geophys. J. Int., **201**, 764–782.
- [31] S.S. Pegler, H.E. Huppert, J.A. Neufeld (2014) *Fluid migration between confined aquifers* J. Fluid Mech., **757**, 330–353.
- [30] D.R. Hewitt, J.A. Neufeld, J.R. Lister (2014) *High Rayleigh number convection in a porous medium containing a thin low-permeability layer* J. Fluid Mech. **756**, 844–869.
- [29] D.R. Hewitt, J.A. Neufeld, J.R. Lister (2014) *High Rayleigh number convection in a three-dimensional porous medium* J. Fluid Mech. **748**, 879–895.
- [28] S.S. Pegler, H.E. Huppert, J.A. Neufeld (2014) *Fluid injection into a confined porous media.* J. Fluid Mech. **745**, 592–620.
- [27] H.E. Huppert, J.A. Neufeld (2014) *The fluid mechanics of carbon dioxide sequestration* Ann. Rev. Fluid Mech. **46**, 255-272.
- [26] K.H. Lythgoe, A. Deuss, J.F. Rudge, J.A. Neufeld (2014) *Earth’s inner core: innermost inner core or hemispherical variations?* Earth. Planet. Sci. Lett. **385**, 181-189.
- [25] D.R. Hewitt, J.A. Neufeld, J.R. Lister (2013) *Stability of columnar convection in a porous medium.* J. Fluid Mech. **737**, 205–231.
- [24] S.S. Pegler, J.A. Neufeld, H.E. Huppert (2013) *Topographic controls on gravity currents in porous media* J. Fluid Mech. **734**, 314–337.
- [23] J.R. Lister, G.P. Peng, J.A. Neufeld (2013) *Viscous peeling of an elastic sheet by bending and pulling.* Phys. Rev. Lett. **111**, 154501.
- [22] B. Zhao, C.W. MacMinn, M.L. Szulczewski, J.A. Neufeld, H.E. Huppert, R. Juanes (2013) *Interface pinning of immiscible gravity-exchange flows in porous media* Phys. Rev. E. **87** 023015.
- [21] H.E. Huppert, J.A. Neufeld, C. Strandkvist (2013) *The competition between gravity and flow focusing in two-layered porous media.* J. Fluid Mech. **720** 5-14.
- [20] M.J. Golding, H.E. Huppert, J.A. Neufeld (2013) *The effects of capillary forces on the axisymmetric propagation of two-phase, constant-flux gravity currents in porous media.* Phys. Fluids. **25**, 036602.
- [19] D.R. Hewitt, J.A. Neufeld, J.R. Lister (2013) *Convective shutdown in a porous medium at high Rayleigh number.* J. Fluid Mech. **719**, 551-586.
- [18] K.A. Daniels, H.E. Huppert, J.A. Neufeld, D. Reiner (2012) *The current state of CCS: Ongoing research at the University of Cambridge with application to the UK policy framework* Cambridge Working Paper in Economics 1257.

- [17] C. MacMinn, M.A. Hesse, J.A. Neufeld, H.E. Huppert (2012) *Spreading and convective dissolution of carbon dioxide in vertically confined, horizontal aquifers*. Water Res. Res. doi:10.1029/2012WR012286.
- [16] D.R. Hewitt, J.A. Neufeld, J.R. Lister (2012) *Ultimate regime of high Rayleigh number convection in a porous medium*. Phys. Rev. Lett. **108**, 224503.
- [15] F.C. Boait, N.J. White, M.J. Bickle, R.A. Chadwick, J.A. Neufeld, H.E. Huppert (2012) *Spatial and Temporal Evolution of Injected CO₂ at the Sleipner Field, North Sea*. J. Geophys. Res. **117**, B03309.
- [14] M. Golding, J.A. Neufeld, M. A. Hesse, H. E. Huppert (2011) *Two-phase gravity currents in porous media*. J. Fluid Mech. **678**, 248-270.
- [13] P. Zimoch, J.A. Neufeld, D. Vella (2011) *The effect of a fissure on storage in inclined porous reservoirs*. J. Fluid Mech. **673**, 395-405.
- [12] D. Vella, J.A. Neufeld, H.E. Huppert, J.R. Lister (2011) *Leakage from gravity currents in a porous medium. Part II. A line sink*. J. Fluid Mech. **666**, 414-427.
- [11] J.A. Neufeld, D. Vella, H.E. Huppert, J.R. Lister (2011) *Leakage from gravity currents in a porous medium. Part I. A localized sink..* J. Fluid Mech. **666**, 391-413.
- [10] J.A. Neufeld, J.S. Wettlaufer (2011) *Shear flow, phase change and matched asymptotic expansions: pattern formation in mushy layers*. Physica D. **240**, 140-149.
- [9] J.A. Neufeld, M.A. Hesse, A. Riaz, M.A.Hallworth, H.A. Tchelepi, H.E. Huppert. (2010) *Convective dissolution of carbon dioxide in saline aquifers*. Geophys. Res. Lett. **37**, L22404, doi:10.1029/2010GL44728.
- [8] J.A. Neufeld, R.E. Goldstein, M.G. Worster. (2010) *On the mechanisms of icicle evolution*. J. Fluid Mech. **647**, 287-308.
- [7] J.A. Neufeld, D.Vella, H.E. Huppert. (2009) *The effect of a fissure on storage in a porous medium*. J. Fluid Mech. **639**, 239–259.
- [6] J.A. Neufeld, H.E. Huppert. (2009) *Modelling carbon dioxide sequestration in layered strata*. J. Fluid Mech. **625** 353-370.
- [5] M.J. Spannuth, J.A. Neufeld, J.S. Wettlaufer, M.G. Worster. (2009) *Axisymmetric viscous gravity currents flowing over a porous medium*. J. Fluid Mech. **622** 135-144.
- [4] M.J. Leahy, J. Ennis-King, J. Hammond, H.E. Huppert, J. Neufeld. (2009) *Application of gravity currents to the migration of CO₂ in heterogeneous saline formations*. Energy Procedia. **1**, 3331-3338.
- [3] J.A. Neufeld, J.S. Wettlaufer. (2008) *An experimental study of shear-enhanced convection in a mushy layer*. J. Fluid Mech. **612** 363-385.
- [2] J.A. Neufeld, J.S. Wettlaufer. (2008) *Shear-enhanced convection in a mushy layer*. J. Fluid Mech. **612** 339-361.
- [1] J.A. Neufeld, J.S. Wettlaufer, D.L. Feltham, M.G. Worster. (2006) *CORRIGENDUM to Flow-induced morphological instability of a mushy layer (Feltham, D.L. & Worster, M.G., Journal of Fluid Mechanics 391, 337-357)*. J. Fluid Mech. **549** 442-443.

Students

Madeleine Golding (DAMTP) Multiphase modelling of CO₂ sequestration (PhD, defended 01/2013).

Duncan Hewitt (DAMTP) Convective dissolution of sequestered CO₂ (PhD, defended 05/2014).

Karen Lythgoe (Earth Sciences) Seismic imaging and modelling of Earth's inner core (PhD, defended 02/2015).

Peter Ford (DAMTP) Crystallization in polynyas (MSc, defended 10/2014)

Andrew Gilbert (Earth Sciences) Solidification of magma chambers (current PhD)

Laurence Cowton (Earth Sciences) Seismic imaging and modelling of CO₂ (current PhD)

Japinder Nijjer (DAMTP) Mixing in heterogeneous porous media (current PhD)

Thomasina Ball (Earth Sciences) Emplacement of magma in Earth's crust (current PhD)

Postdocs

Roiy Sayag (DAMTP) Subglacial drainage systems, fluid flow and elastic flexure (2013-2014)

Sam Pegler (DAMTP) Models of propagation and leakage in confined porous media. (2013-2014)

Himantha Cooray (DAMTP) Capillary forces in idealised porous media (2013 - present)

Katherine Daniels (Earth Sciences) geochemical mixing in heterogeneous formations. (2013-2014)

Finn Box (BPI) Fracture reduction through particulates. (2014 - present)

Baudouin Géraud (DAMTP) Permeability of sea ice and poroelastic media. (2015 - present)

Zoja Vukmanovic (Earth Sciences) Crystallisation of magma chambers (2015 - present)

Professional service

Reviewer Journal of Fluid Mechanics, Physics of Fluids, Journal of Glaciology, Journal of Crystal Growth, Earth and Planetary Science Letters, Geochemistry Geophysics Geosystems, Engineering Physical Sciences Research Council, Physical Review E

Community Service

2016 co-organizer Isaac Newton Trust program on *Melt in the mantle*, Cambridge, UK.

2014 Organising committee, Joint AAPG-GSL meeting on the Storage of Carbon Dioxide, London, UK.

2014 Organising committee, UK-India Frontiers of Science meeting, Mumbai, India.

2011–present Co-founder, Geophysical and Environmental Processes seminar, DAMTP, University of Cambridge.

2008–present Organiser, Tuesday Theoretical Geophysics seminar, DAMTP, University of Cambridge.

2012, 2014 Organising committee, Fluid dynamics of sustainability and the environment, DAMTP, University of Cambridge & Ecole Polytechnique.

2012 Organiser & Chair, Carbon sequestration mini-symposium, European Fluid Mechanics Conference 9, Rome, Italy.

2011 Co-organiser, The fluid dynamics of geological carbon sequestration mini-symposium, APS DFD, Baltimore, USA.

2009 & 2010 Co-convener Pattern formation in Earth Sciences sessions at the fall AGU.

2009 & 2010 Co-organiser, Friday fluid dynamics seminar, DAMTP, University of Cambridge

2003–2006 Geology & Geophysics Dept. colloquium committee, Yale University

Presentations

2015 UKCCS meeting, Imperial College (London, UK); Department of Earth Science and Engineering, Imperial College (London, UK); John Ray Society, St. Catharine’s College (Cambridge, UK); Engineering Department, University of Cambridge (Cambridge, UK); Energy Sciences Institute, Yale University (New Haven, USA), Department of Geology and Geophysics, Yale University (New Haven, CT); Industrial Associates, Department of Earth Sciences, University of Cambridge (Cambridge, UK); Fluid and Elasticity conference (Biarritz, France); Fields Institute, University of Toronto (Toronto, Canada)

2014 Gordon Research Conference on Porous Media Flows (Bates College, ME, USA), Engineering Department, University of Cambridge (Cambridge, UK); Geological Society London (London, UK); Department of Earth Sciences, Harvard University (Cambridge, USA); TRUST consortium meeting (Goettingen, Germany); American Physical Society, Division of Fluid Dynamics (San Francisco, CA, USA); St. Catharine’s College at Credit Suisse (London, UK); Bullard Laboratories, Department of Earth Sciences, University of Cambridge (Cambridge, UK);

- Concepts & Conundrums in Reacting and Deformable Porous Media, Oxford University (Oxford, UK); G.K. Batchelor Lab reunion, Department of Applied Mathematic and Theoretical Physics, University of Cambridge (Cambridge, UK)
- 2013 PANACEA consortium meeting (Montpellier); Department of Earth Sciences, University of Oxford (Oxford, UK); IPGP (Paris, France); PANACEA consortium meeting (Paris, France); St. Catharine's college at the Royal Society (London, UK); FAST (Paris, France)
- 2012 BP Refining (Hull, UK); Industrial Associates, Department of Earth Sciences, University of Cambridge (Cambridge, UK); Max Planck Institute for Dynamics and Self-Organization (Goettingen, Germany); Lloyds of London (London, UK); Centre for Nonlinear Dynamics, University of Manchester (Manchester, UK), Department of Mathematics, University of Strathclyde (Glasgow, UK); American Physical Society, Division of Fluid Dynamics (San Diego, USA)
- 2011 Department of Geophysical Sciences, University of Chicago (Chicago), School of Earth and Environment, University of Leeds (Leeds), MIT, Department of Earth and Atmospheric Physics, (Cambridge MA), Department of Geological Sciences, University of Oregon (Eugene), American Physical Society Division of Fluid Dynamics (Baltimore), American Geophysical Union Fall Meeting (San Francisco)