

DR FRED RICHARDS

Imperial College Research Fellow, Imperial College London

Geophysicist and geologist with expertise in geodynamics, palaeoclimate, and geomorphology.

ACADEMIC POSITIONS

Oct 2019 – Present: Imperial College Research Fellow

Department of Earth Science and Engineering, Imperial College London

- 4 research manuscripts published: *EPSL*, *GJI*, *JGR*, and *PEPI* (invited); 4 in rev.: *AGU Adv.*, *Miner. Depos.*, and *Elsevier Science*; 5 in prep. for 2022 submission, including: *Nature*, *GRL*, *JGR*, and *EPSL*.
- 9 invited conference talks and seminars, including: SEG (keynote), SEDI, and ETH Zurich.
- 2 invited chapters for *Encyclopaedia of Quaternary Science* and *Elsevier Science* (in rev.).
- Awarded Geological Society of London's 2022 William Smith Fund for "excellence in contributions to geoscience research and its application".
- Offered A\$170,000 (~£95,000) grant from Geoscience Australia to study Earth structure and dynamics.
- PhD supervision/co-supervision: James Hazzard (2020-Present)/Matt Morris (2022-Present).
- Collab. network: Oxford, Imperial, Harvard, Berkeley, Columbia, Los Alamos, ANU, and GFZ Potsdam.

Sep 2018 – Sep 2019: Schmidt Science Fellow

Department of Earth and Planetary Sciences, Harvard University

- 5 manuscripts published, including: *Nat. Geosci.*, *Ann. Rev. Earth Plan. Sci.*, and *Icarus*.
- 5 invited talks, including: AGU, EGU, and IUGG.
- Mineral deposit research estimated to be worth [A\\$147-752 million](#) (~£85-430 million) to the Australian economy by independent consultancy, ACIL Allen; covered in *The Economist* and *Scientific American*.
- Developed new collaborations with researchers at institutions including Harvard, Columbia, and ANU.

EDUCATION

Oct 2014 – Aug 2018: PhD Earth Sciences – passed with no corrections.

Bullard Laboratories, Department of Earth Sciences & Jesus College, University of Cambridge

Thesis: *Global Analysis of Predicted and Observed Dynamic Topography* (NERC ESS DTP-funded)

- Awarded an RAS Keith Runcorn Prize for best thesis in geophysics and planetary science (runner-up).
- Received *G³* Editors' Highlight award for paper on topographic evolution of Indian Peninsula.
- 3 first-author papers published in *G³* and *JGR*; invited talks at Imperial and Columbia.

Oct 2010 – Jun 2014: MSci Earth Sciences: 1st Class Honours – graduated top of the class.

Department of Earth Sciences & St. Anne's College, University of Oxford

GRANTS & AWARDS

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|------------------|---|
| 2022 | Geological Society of London William Smith Fund (£500) for "excellence in contributions to applied and economic aspects of geoscience".
Imperial College Wings for Ideas Fund (£2,500)
Title: <i>Making Machine Learning-Based Treasure Maps for Critical Metal Resources</i> |
| 2022–2024 | Geoscience Australia – Exploring for the Future Program (A\$170,000; ~£95,000)
Title: <i>Dynamics of the Australian Upper Mantle: Impacts on Future Sea-Level Change and Mineral Deposit Formation</i> |
| 2020–2024 | SSCP DTP Fieldwork Fund (£10,000)
Notes: Awarded to partially cover field trip to Greenland and dating of rock samples. |

- 2019–2023 Imperial College Research Fellowship (~£48,500 p.a. + £28,200 research expenses)**
 Title: *Quantifying the Impact of Earth’s Internal Dynamics on the Cryosphere*
 Notes: 1 of 20 selected.
- 2018–2019 Schmidt Science Fellows in partnership with the Rhodes Trust (\$100,000; ~£75,000)**
 Title: *Contribution of Solid Earth Dynamics to Late Cenozoic Relative Sea-Level Change*
 Notes: 1 of 14 selected in inaugural class, only successful UK, and geoscience applicant.
- 2018 RAS Keith Runcorn Prize** for best thesis in geophysics and planetary science – runner-up.
- 2017 G³ Editors’ Highlight** for first-author paper (“*Cenozoic Epeirogeny of the Indian Peninsula*”).
- 2015 Jesus College Travel Grant (£500)** – used to attend EGU 2015, Vienna.
- 2014–2018 NERC PhD Studentship (£14,000 p.a. + £10,000 research expenses).**
- 2014 BP Prize** for best MSci Project, Oxford Earth Sciences Department.
- 2013 Burdett-Coutts Prize** for top mark in Final Honour School, Oxford Earth Sciences Department.
- 2013 Shell Prize** for top mark in Geochemistry, Oxford Earth Sciences Department.
- 2011-2014 St. Anne’s College & University of Oxford Scholarship** for performance in examinations.

TEACHING & SUPERVISION

- Research Supervision**
- Principal PhD supervisor of James Hazzard, Imperial SSCP DTP student (2019-Present), AGU 2021 OSPA award winner. Co-supervisor of Matthew Morris (2022-Present).
 - Sian Arnold (2020), MSc project, Imperial Applied Comp. Sci. and Engineering.
 - Supervised and designed projects for 2 visiting PhD students at Cambridge (2017).
- Postgraduate**
- Co-designed and led 4 practical sessions for Modelling and Numerical Methods - Part I module of Imperial Applied Comp. Sci. and Engineering MSc (2021).
 - Delivered Imperial Petroleum Geosci. MSc Basin Analysis lecture & practical (2020).
 - Delivered lecture to Harvard Sea Level Change course (2019; ‘Q’ score of 4.5 out of 5).
- Undergraduate**
- Lecturer for Imperial 3rd-Year Continental Tectonics (2019-2021), delivering 7 lectures and practicals, and 2 revision sessions. Received universally positive ‘SOLE’ feedback and 2 bonuses from departmental management committee for “*excellent contributions*” to teaching.
 - Supervisor (~8 hrs/term) and demonstrator (~2 hrs/wk) for Cambridge Sed. Basins (2nd-Year), Core Geophysics (3rd-Year) and Lithospheric Dynamics (4th-Year) courses (2014-2018).
- Field Teaching**
- Demonstrator and group leader on 4th-Year Apennines virtual field trips (2020 & 2021). Course handbook, practical sessions and Jupyter notebooks for geophysical element.
 - Demonstrator on Cambridge Isle of Arran Field Trip (2018).

FIELD EXPERIENCE

- 2018 Geochronological Sampling and GPS Surveying:** Field assistant on 2-week trip to Bahamas to sample and survey MIS 5 corals and beach rocks on Eleuthera to build sea-level chronology.
- 2015 Geochronological Sampling, GPS, and Drone Surveying:** Field assistant on 4-week trip to Madagascar. GPS and drone surveyed raised coral terraces. Collected basalt for rare earth element inversion, corals for U-Th dating, and granitic/gneissic samples for apatite fission track analysis (AFTA) and apatite-helium geochronology (AHe).
- 2012 Bedrock Mapping:** 5-week long mapping project on Bracco Ophiolite in Liguria, Italy.

INVITED TALKS

(K) = keynote or plenary

- 2022** **Richards, F. D.**, Mapping upper mantle structure and its impact on mineral deposit formation, Georesources Virtual Seminar, **GFZ Potsdam/UFZ Leipzig/GEOMAR**, Potsdam/Leipzig/Kiel (DE).
- 2021** **Richards, F. D.**, Inferring upper mantle thermomechanical structure using calibrated parameterisations of anelasticity, GFZ Potsdam Basin Modelling Seminar, **GFZ Potsdam**, Potsdam (DE).
- Richards, F. D.**, How high will sea-levels rise? Lessons from the geological record, Climate Change: Impacts and Innovations Virtual Conference in association with **Schmidt Science Fellows**.
- Richards, F. D. (K)**, Gigayear stability of cratonic edges controls global distribution of sediment-hosted metals, **Society of Economic Geologists 100 Meeting**, Whistler (CA).
- 2020** **Richards, F. D.**, Hoggard, M. J., Ghelichkhan, S. & Lau, H. C. P., What Are LLSVPs? Geodynamic Insights into Lower Mantle Chemistry and Structure, **SEDI 2020**, Taipei (TW). Postponed to 2022.
- Richards, F. D.**, Mapping Seismic Tomography into Earth Structure: Implications for Dynamic Topography, Lithospheric Stability, and Sea-Level Reconstructions, Bullard Laboratories Wednesday Seminar, **University of Cambridge**, Cambridge (UK).
- Richards, F. D.**, Earth's Dynamic Topography: Implications for Mantle Structure and Sea-Level Records, Geophysical Fluid Dynamics Seminar, **ETH Zürich**, Zürich (CH).
- Richards, F. D.**, Mapping Seismic Tomography into Upper Mantle Structure: Implications for Dynamic Topography and Sea-Level Reconstructions, Earth and Planets Seminar, **Imperial College**, London (UK).
- Richards, F. D.**, Gigayear stability of cratonic edges controls global distribution of sediment-hosted metals, Mineral Deposits Group Seminar, **Natural History Museum**, London (UK).
- 2019** **Richards, F. D.**, Hoggard, M. J., Ghelichkhan, S. & Lau, H. C. P., What Are LLSVPs? Geodynamic Insights into Lower Mantle Chemistry and Structure, **AGU Fall Meeting**, San Francisco (USA), DI23A-03.
- Richards, F. D.**, Hoggard, M. J., Ghelichkhan, S. & Lau, H. C. P., The Role of LLSVPs in Reconciling Observations and Predictions of Earth's Dynamic Topography, **IUGG**, Montréal (CA), IUGG19-3669.
- Richards, F. D.**, Hoggard, M. J., Ghelichkhan, S. & Lau, H. C. P., Reconciling Observations and Predictions of Earth's Dynamic Topography, *Geophysical Research Abstracts*, **21**, **EGU**, Vienna (AT), EGU2019-3744.
- Richards, F. D.**, Mapping Upper Mantle Heterogeneity and Its Impact on Dynamic Topography, Geodynamics Seminar, **Lamont-Doherty Earth Observatory, Columbia University**, Palisades (USA).
- 2018** **Richards, F. D.**, Reconciling Observations and Predictions of Earth's Dynamic Topography, BiSEPPS Seminar, **Harvard University**, Cambridge (USA).
- Richards, F. D.**, Global Dynamic Topography and its Impact on Australian Sea-Level, Friends of PlioMax Meeting, **Lamont-Doherty Earth Observatory, Columbia University**, Palisades (USA).
- Richards, F. D.**, Resolving Discrepancies Between Observed and Predicted Dynamic Topography, Earth and Planets Seminar, **Imperial College**, London (UK).
- N.B. 37 regular conference presentations at AGU (26), EGU (10), IUGG (1) not shown.*

SELECTED MEDIA COVERAGE

- 2020** Scientific American: [“Science Pinpoints Global Metal Deposit Locations”](#).
Eos: [“Cratons Mark the Spot for Mineral Bonanzas”](#).
- 2019** The Economist: [“Ore bodies, it has been discovered, are not randomly distributed”](#).
Mining Journal: [“The story behind one of the year's biggest discoveries”](#).

ACADEMIC SERVICE

- 2021** • Lead convenor of *Links Between Earth's Internal Dynamics and Surface Evolution from Archean to Present* session at 2021 AGU Fall Meeting, New Orleans (USA).
- 2020–Present** • Events Team Lead, Royal Astronomical Society Early Career Network.
• Imperial College Earth & Planets Seminar organiser.
• Geodynamics, Climate and Surface Processes Reading Group founder and organiser.
• Imperial-MIT Seed Fund Review Panel member (1 of 4 selected).
- 2019–Present** • Developer of NSF-supported open-source code ASPECT (aspect.geodynamics.org) that solves the equations governing thermochemical convection in planetary mantles.
- 2018–2019** • Harvard University Graduate Student and Postdoc Seminar organiser.
- 2016–Present** • Peer Reviewer: *AGU Books*, *Earth-Science Reviews*, *G³*, *Geology*, *GRL*, *JGR*, *Mar. Geophys. Res.*, *PEPI*, *Proc. R. Soc. Lond. A*, *Science Advances* (x2).

OUTREACH & PUBLIC POLICY ENGAGEMENT

- 2021** • Organised and chaired 3 careers events and a poster competition for RAS Early Career Network.
• Application shortlisted for Royal Society Pairing Scheme, connecting researchers to politicians.
• “How to become a Geologist” talk for School21 Career Paths (<https://www.youtube.com/watch?v=l2jC5zz2o7s>).
- 2020** • Invited post on dynamic topography for [EGU's Geodynamics blog](#).
• “What's Our Planet Made Of?” outreach event at Hurlingham School.
• Speaker at UCL Insight “Careers in Research within Academia” event.
- 2019** • Co-organised AGU Town Hall session entitled “Disaster Policies or Disastrous Policies? A Town Hall at the Junction of Natural Hazards, Society, Science Policy, and Communication”.
• Wrote article on science-policy interaction for [Schmidt Science Fellows website](#).
- 2017** • Organised and coordinated Planet Earth section of Cambridge Pint of Science festival; chaired “Breathe Easy: The Future of Energy Is Here” evening (16th May).
- 2016–2018** • Workshops Coordinator for Cambridge University Science and Policy Exchange.

MEMBERSHIPS

- 2015–Present** Royal Astronomical Society, European Geosciences Union, American Geophysical Union.
- 2010–Present** Geological Society of London, Royal Geographical Society.

PUBLICATIONS

* = yet to be published; ^ = not research-related; † = equal contribution.

- In Review** (18*) Hazzard, J. A. N., **Richards, F. D.**, Roberts G. G. & Goes, S. D. B., Probabilistic Assessment of Antarctic Thermomechanical Structure: Impacts on Ice Sheet Stability, *under review at J.*

Geophys. Res. Solid Earth, preprint doi: [10.31223/X5C35R](https://doi.org/10.31223/X5C35R). Received [Outstanding Student Presentation Award](#) at AGU Fall Meeting 2021.

(17*) Davies, D. R., Ghelichkhan, S., Hoggard, M. J., Valentine, A. P. & **Richards, F. D.**, Observations and Models of Dynamic Topography: Current Status and Future Directions, *under review at Elsevier Science (Dynamics of plate tectonics and mantle convection - Ed: J.C. Duarte)*, preprint doi: [10.31223/X55W5T](https://doi.org/10.31223/X55W5T). Invited book chapter.

(16*) **Richards, F. D.**, Hoggard, M. J., Ghelichkhan, S., Koelemeijer, P. & Lau, H. C. P., Geodynamic, Geodetic and Seismic Constraints Favour Deflated and Dense-Cored LLVPs, *under review at AGU Advances*, preprint doi: [10.31223/X55601](https://doi.org/10.31223/X55601).

(15*) Huston, D. L., Champion, D. C., Czarnota, K., Duan, J., Hutchens, M., Paradis, S. G., Hoggard, M. J., Ware, B. D., Gibson, G. M., Doublier, M. P., Kelley, K. D., McCafferty, A. E., Hayward, N., **Richards, F. D.**, Tessalina, S. D. & Carr, G. R., Zinc on the edge: isotopic and geophysical evidence that cratonic edges control shale-hosted zinc-lead deposits, *under review at Mineralium Deposita*, preprint [link](#).

2021

(14) Austermann, J., Hoggard, M. J., Latychev, K., **Richards, F. D.** & Mitrovica, J. X., The effect of lateral variations in Earth structure on Last Interglacial sea level, *Geophys. J. Int.*, **227**, pp. 1938-1960, doi: [10.1093/gji/ggab289](https://doi.org/10.1093/gji/ggab289).

(13) Ghelichkhan, S., Fuentes, J. J., Hoggard, M. J., **Richards, F. D.** & Mitrovica, J. X., The Precession Constant and its Long-Term Variation, *Icarus*, **358**, 114172, doi: [10.1016/j.icarus.2020.114172](https://doi.org/10.1016/j.icarus.2020.114172).

(12[^]) O'Brien, A. C., Boubert, D., Bowman, D. M., **Richards, F. D.** & Maunder, M., Pandemic Posters, *Astron. Geophys.*, **62**(1), pp. 19, doi: [10.1093/astrogeo/atab039](https://doi.org/10.1093/astrogeo/atab039).

(11[^]) Bowman, D. M., Maunder, M., **Richards, F. D.**, O'Brien, A. C. & Boubert, D., Hear it through the grapevine, *Astron. Geophys.*, **62**(4), pp. 12-14, doi: [10.1093/astrogeo/atab076](https://doi.org/10.1093/astrogeo/atab076).

2020

(10) **Richards, F. D.**, Hoggard, M. J., Crosby, A. G., Ghelichkhan, S. & White, N. J., Structure and Dynamics of the Oceanic Lithosphere-Asthenosphere System, *Phys. Earth Plan. Int.*, **309**, 106559, doi: [10.1016/j.pepi.2020.106559](https://doi.org/10.1016/j.pepi.2020.106559). Invited submission.

(9) **Richards, F. D.**, Hoggard, M. J., White, N. J. & Ghelichkhan, S., Quantifying the relationship between short-wavelength dynamic topography and thermomechanical structure of the upper mantle using calibrated parameterization of anelasticity, *J. Geophys. Res.: Solid Earth*, **125**, e2019JB019062, doi: [10.1029/2019JB019062](https://doi.org/10.1029/2019JB019062).

(8) Hoggard, M. J. †, Czarnota, K. †, **Richards, F. D.** †, Huston, D. L., Jaques, A. L. & Ghelichkhan, S., Global distribution of sediment-hosted metals controlled by craton edge stability, *Nature Geoscience*, **13**, pp. 504-510, doi: [10.1038/s41561-020-0593-2](https://doi.org/10.1038/s41561-020-0593-2).

(7) Klöcking, M., Hoggard, M. J., Rodríguez Tribaldos, V., **Richards, F. D.**, Guimarães, J. A., MacLennan, J. C. & White, N. J., A tale of two domes: Neogene to recent volcanism and dynamic uplift of northeast Brazil and southwest Africa, *Earth Plan. Sci. Lett.*, **547**, 116464, doi: [10.1016/j.epsl.2020.116464](https://doi.org/10.1016/j.epsl.2020.116464).

(6) Mitrovica, J. X., Austermann, J., Coulson, S. L., Creveling, J. R., Hoggard, M. J., Jarvis, G. T. & **Richards, F. D.**, Dynamic Topography and Ice Age Paleoclimate, *Ann. Rev. Earth Planet. Sci.*, **48**(1), pp. 585-621, doi: [10.1146/annurev-earth-082517-010225](https://doi.org/10.1146/annurev-earth-082517-010225).

(5) Czarnota, K., Hoggard, M. J., **Richards, F. D.**, Teh, M., Huston, D. L., Jacques, A. L. & Ghelichkhan, S., Minerals on the edge: Sediment-hosted base metal endowment above steps in

lithospheric thickness, *Exploring for the Future: Extended Abstracts*, Geoscience Australia, Canberra, doi: [10.11636/134991](https://doi.org/10.11636/134991).

(4) Huston, D. L., Champion, D. C., Czarnota, K., Hutchens, M., Hoggard, M. J., Ware, B. D., **Richards, F. D.**, Tessalina, S. D., Gibson, G. M. & Carr, G., Lithospheric-scale controls on zinc-lead-silver deposits of the North Australian Zinc Belt: evidence from isotopic and geophysical data, *Exploring for the Future: Extended Abstracts*, Geoscience Australia, Canberra, doi: [10.11636/134276](https://doi.org/10.11636/134276).

2018 (3) **Richards, F. D.**, Kalnins, L. M., Watts, A. B., Cohen, B. E. & Beaman R. J., The Morphology of the Tasmantid Seamounts: Interactions Between Tectonic Inheritance and Magmatic Evolution, *Geochem. Geophys. Geosyst.*, **19**, pp. 3870-3891, doi: [10.1029/2018GC007821](https://doi.org/10.1029/2018GC007821).

(2) **Richards, F. D.**, Hoggard, M. J., Cowton, L. R. & White, N. J., Reassessing the Thermal Structure of Oceanic Lithosphere with Revised Global Inventories of Basement Depths and Heat Flow Measurements, *J. Geophys. Res.: Solid Earth*, **123**, pp. 9136-9161, doi: [10.1029/2018JB015998](https://doi.org/10.1029/2018JB015998).

2016 (1) **Richards, F. D.**, Hoggard, M. J. & White, N. J., Cenozoic Epeirogeny of the Indian Peninsula, *Geochem. Geophys. Geosyst.*, **17**, pp. 1525-2027, doi: [10.1002/2016GC006545](https://doi.org/10.1002/2016GC006545).

MANUSCRIPTS IN PROGRESS*

*Only in-progress manuscripts expected to be submitted in 2022 are listed.

Richards, F. D., Coulson, S. L., Austermann, J., Hoggard, M. J. & Mitrovica, J. X., The Impact of Mantle Dynamics on Australian Mid-Pliocene Sea-Level Records, *in prep. for submission to Nature*, bibcode: [2020AGUFMDI014..05R](https://arxiv.org/abs/2020AGUFMDI014..05R), presentation [link](#).

Coulson, S. L., **Richards, F. D.**, Hoggard, M. J., Austermann, J. & Mitrovica, J. X., Dynamic Topography Across the Canadian Arctic and Implications for Plio-Pleistocene Glacial Inception, *in prep. for submission to Earth Plan. Sci. Lett.*, bibcode: [2019AGUFM.C14B..07C](https://arxiv.org/abs/2019AGUFM.C14B..07C), presentation [link](#).

Hoggard, M. J., Shorttle, O., **Richards, F. D.**, White, N. J. & MacLennan J. C., Reconciling Geophysical and Geochemical Observations of Supercontinent Insulation, *under review at Earth Plan. Sci. Lett.*, preprint [link](#).

Ghelichkhan, S., Moore K. M., Hoggard, M. J., **Richards, F. D.**, Chan, N.-H., Creveling, J. R. & Mitrovica, J. X., Closing the budget of 20th Century True Polar Wander, *in prep. for submission to Geophys. Res. Lett.*, preprint [link](#).

Richards, F. D., Modelling global mean sea level since the Pliocene, *in prep. for submission to Encyclopedia of Quaternary Science*. Invited book chapter.

REFEREES

Gareth G. Roberts, Senior Lecturer, Department of Earth Science and Engineering, Imperial College London.
Email: gareth.roberts@imperial.ac.uk, Tel: +44 (0)20 7594 7363.

Jerry X. Mitrovica, Frank Baird, Jr. Professor of Science, Department of Earth and Planetary Sciences, Harvard University.
Email: jxm@eps.harvard.edu, Tel: +1 617 496 2732.

Nicholas J. White, Professor of Cymatogeny, Bullard Laboratories, Department of Earth Sciences, University of Cambridge.
Email: njw10@cam.ac.uk, Tel: +44 (0) 1223 337063.

Jacqueline Austermann, Assistant Professor, Department of Earth and Environmental Sciences, Columbia University.
Email: jackya@ldeo.columbia.edu, Tel: +1 845 365 8971.

Anthony B. Watts, Professor of Marine Geophysics, Department of Earth Sciences, University of Oxford. Email: tony@earth.ox.ac.uk, Tel: +44 (0) 1865 282121.