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Ph.D.

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Education

Ph.D., University of California Santa Cruz, Earth and Planetary Science, 2009-2015

Advisor: James C. Zachos, *Committee:* A. Christina Ravelo, Paul L. Koch Richard E. Zeebe (*External*)

Thesis Title: The response of seawater carbonate chemistry to rapid carbon injection during the Paleocene-Eocene Thermal Maximum

B.A., Carleton College, Northfield, Minnesota 2003-2007, Geology major

Professional Appointments

Postdoctoral Associate, Geology & Geophysics, Yale University, 2017-present

Richard Foster Flint Postdoctoral Fellow at Yale University, 2015-2017

Collaborators: Pincelli Hull and Noah Planavsky

International Ocean Discovery Project Expedition 371 (Tasman Paleogene tectonics and climate) July-September 2017

Shipboard sedimentologist

Teaching and Research Assistant at the University of California Santa Cruz 2009-2014

IODP Expedition 342 (Newfoundland drifts) June-August 2012

Shipboard sedimentologist

Research Staff, Lamont-Doherty Earth Observatory: 2007-2009

Supervisor: Dr. Bärbel Hönlisch

Publications

- 17) Penman, D. E., & Kirtland Turner, S (2019).** The influence of circulation change on sedimentary records of the Paleocene-Eocene Thermal Maximum. *Past Global Changes*, 27(2), 68-69, doi:10.22498/pages.27.2.68
- 16) Penman, D. E., Keller, A., D'haenens, S., Kirtland Turner, S., & Hull, P. M. (2019).** Atlantic deep-sea cherts associated with Eocene hyperthermal events. *Paleoceanography and Paleoclimatology*, 34(2), 287-299
- 15) Penman, D. E. & Rooney, A. D. (2019).** Coupled carbon and silica cycle perturbations during the Marinoan snowball Earth deglaciation. *Geology*, 47(4), 317-320.
- 14) Farmer, J. R., Branson, O., Uchikawa, J., Penman, D. E., Hönlisch, B., & Zeebe, R. E. "Boric acid and borate incorporation in inorganic calcite inferred from B/Ca, boron isotopes and surface kinetic modeling." *Geochimica et Cosmochimica Acta* 244 (2019): 229-247.**
- 13) Penman, D. E., Zachos, J. C., New constraints on carbon release and recovery processes during the Paleocene-Eocene Thermal Maximum (2018).** *Environmental Research Letters*, 13(10), 105008.

- 12) Babila, T. L., **Penman, D. E.**, Hönisch, B., Kelly, D. C., Bralower, T. J., Rosenthal, Y., & Zachos, J. C. (2018). Capturing the global signature of surface ocean acidification during the Palaeocene-Eocene Thermal Maximum. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, 376(2130).
- 11) Expedition 371 Scientists (2018). Tasman Frontier Subduction Initiation and Paleogene Climate. *IODP Prel. Rept.*, 371. doi:10.14379/iodp.pr.371.2018
- 10) Uchikawa, J., Harper, D. T., **Penman, D. E.**, Zachos, J. C., Zeebe, R. E. (2017). Influence of solution chemistry on boron content in inorganic calcite grown in artificial seawater, *Geochemica et Cosmochimica Acta* 218 (2017): 291-307
- 9) Hull, P.M., Bohaty, S.M., Cameron, A., Coxall, H.K., D'haenens, S., de Vleeschouwer, D., Elder, L.E., Friedrich, O., Kerr, K., Kirtland Turner, S., Kordesch, W.E.C., Moriya, K., Norris, R.D., Opdyke, B.N., **Penman, D. E.**, Pälike, H., Sexton, P., Vahlenkamp, M., Wilson, P., Wu, F., Zachos, J.C. (2017). Data Report: coarse fraction record for the Eocene megasplice at IODP Sites U1406, U1408, U1409, and U1411. In Norris, R.D., Wilson, P.A., Blum, P., and the Expedition 342 Scientists, *Proceedings of the Integrated Ocean Drilling Program, Volume 342*.
- 8) **Penman, D. E.** (2016). Silicate weathering and North Atlantic silica burial during the Paleocene-Eocene Thermal Maximum. *Geology* 44.9 (2016): 731-734.
- 7) Carter, S. C., Griffith, E. M., **Penman, D. E.** (2016). Peak intervals of equatorial Pacific export production during the Middle Miocene Climate Transition, *Geology* 44.11 (2016): 923-926.
- 6) **Penman, D. E.**, Kirtland Turner, S., Sexton, P. F., Norris, R. D., Dickson, A. J., Boulila, S., Ridgwell, A., Zeebe, R. E., Zachos, J. C., Cameron, A., Westerhold, T., Röhl, U. (2016). An abyssal carbonate compensation depth overshoot in the aftermath of the Palaeocene-Eocene Thermal Maximum, *Nature Geoscience*, 9, 575-580.
- 5) Henahan, M. J., Hull, P. M., **Penman, D. E.**, Schmidt, D. N., Rae, J. W. (2016). Biogeochemical significance of Pelagic Ecosystem Function: An end-Cretaceous Case Study. *Phil. Trans Royal Society B*, 371(1694), 20150510.
- 4) Uchikawa, J., **Penman, D. E.**, Zeebe, R. E., Zachos, J. C. (2015). Experimental evidence for kinetic effects on B/Ca in synthetic calcite: Implications for potential B(OH)₄⁻ and B(OH)₃ incorporation, *Geochimica et Cosmochimica Acta*, 150, 171-191.
- 3) **Penman, D. E.**, B. Hönisch, R. E. Zeebe, E. Thomas, and J. C. Zachos (2014). Rapid and sustained surface ocean acidification during the Paleocene-Eocene Thermal Maximum, *Paleoceanography*, 29, 357–369.
- 2) Expedition 342 Scientists (2013). Paleogene Newfoundland sediment drifts. *IODP Prel. Rept.*, 342. doi:10.2204/iodp.pr.342.2012
- 1) **Penman, D. E.**, Hönisch, B., Rasbury, E. T., Hemming, N. G., & Spero, H. J. (2013). Boron, carbon, and oxygen isotopic composition of brachiopod shells: Intra-shell variability, controls, and potential as a paleo-pH recorder. *Chemical Geology*, 340, 32-39.

Manuscripts in press/review/advanced stage of preparation (drafts of first-authored manuscripts available upon request):

- (accepted, *Science*) Hull, P.M., Bornemann, A., **Penman, D. E.**, Henahan, M.J., & 22 others, Constraining the Role of Impact and Volcanism in Marine Extinctions across the Cretaceous-Paleogene Boundary.
- (accepted, *Geology*) Sutherland, R., Dickens, G.R., and **Expedition 371 Scientists**, Continental scale of geographic change across Zealandia during subduction zone initiation.

- (in review, *Earth Science Reviews*) **Penman, D. E.**, Caves, J., Ibarra, D., Winnick, M., Silicate weathering as a feedback and forcing of Earth's climate and carbon cycle.
- (in review, *Paleoceanography & Paleoclimatology*) Henehan, M. J., Edgar, K. M., Foster, G. L., **Penman, D. E.**, Hull, P. M., et al., Carbon-cycle and potential cryosphere instability in the middle Eocene greenhouse.
- (in review, *Paleoceanography & Paleoclimatology*) Kozdon, R. K., Penman, D. E., Kelly, D. C., Zachos, J. C., Fournelle, J. H., Valley, J. W., Enhanced poleward flux of atmospheric moisture to the Weddell Sea region (ODP Site 690) during the Paleocene-Eocene Thermal Maximum.
- (in review, *Paleoceanography & Paleoclimatology*) Legett, S, Rasbury, E. T., Grossman, E. L., Hemming, N. G., **Penman, D. E.**, The brachiopod boron isotope record across the dynamic Late Paleozoic.
- (in preparation) **Penman, D.E.**, Hull, P. M., Ridgwell, A., Contrasting the response of marine calcifiers and silicifiers to geochemical perturbation during carbon catastrophes.
- (in preparation) Li, F., **Penman, D.E.**, Knudsen, A., Zhao, M., Planavsky, N. Reverse weathering amplifies post-Snowball atmospheric carbon dioxide levels.
- (in preparation) Hood, A.v.S., **Penman, D.E.**, Lechte, M.A., Wallace, M.W., Giddings, J., Planavsky, N.J., Syn-glacial Neoproterozoic carbonates and their implications for the Snowball Earth hypothesis.

Awards & Grants

- Post-Expedition Award following IODP Expedition 371, 2018 (\$15,000): "Paleogene carbon and silica cycle perturbations in the Tasman Sea"
- *Funded*: NSF Paleo perspectives on Climate Change: "The role of pCO₂ in the orbitally-forced climatic cycles of the Cenozoic." Lead proposal author & named Postdoc Penman, PI's Pincelli Hull, Howie Scher, Andy Ridgwell, Sandra Kirtland Turner. \$337,319.00 (Yale), Period of Support 5/1/2017 – 10/30/2019
- *In revision for resubmission*: NSF Marine Geology & Geophysics: "Sedimentary records of Paleogene silica cycling." PI's Donald Penman, Sandra Kirtland-Turner. Universally positive reviews from first submission (2017) available upon request.
- Flint postdoctoral fellowship from Yale University's Department of Geology and Geophysics, 2015 (2 years salary and \$10,000 research funds)
- Post-Expedition Award following IODP Expedition 342, 2013 (\$15,000)
- Named doctoral student, contributed pilot data and proposal text to "Establishing the Magnitude of Sea-Surface Acidification During the Paleocene-Eocene Thermal Maximum," NSF Ocean Acidification, PI's: Jim Zachos, Bärbel Hönisch, Richard Zeebe 2013-2016
- 2012 UCSC Earth & Planetary Science Waters award for top thesis proposal (\$7,000)
- Outstanding Student Presentation Award, 2011 AGU Fall Meeting
- NSF scholarship for Urbino Summer School in Paleoclimatology, 2010
- LDEO's Climate Center grant (2009) to evaluate and calibrate $\delta^{11}\text{B}$ in brachiopod calcite as a paleoproxy for seawater pH (\$8,000)

Invited Talks

- Meeting of the Minds workshop, Hong Kong University (October 2019)
- Penn State University Geosciences Colloquium (October 2019)
- University of British Columbia, Earth Ocean and Atmospheric Science (April 2019)
- Caltech Environmental Science and Engineering seminar series (March 2019)

- University of Texas Arlington (February 2019)
- University of South Carolina Geocheminar (January 2019)
- GFZ-Potsdam (May 2018)
- Hong Kong University Department of Earth Sciences (February 2018)
- AGU 2017, Session: Evaluating Tectonic and Volcanic Forcing of Earth's Climate
- AGU 2016, Session: New insights into the Paleocene-Eocene Thermal Maximum
- University of California Riverside Department of Earth Sciences (April 2016)
- Yale Geology & Geophysics Postdoctoral Seminar (May 2016, May 2017, April 2019)
- Lamont-Doherty Earth Observatory Geochemistry Seminar (Nov 2015)

Teaching and Mentoring

- Teaching assistant for 6 classes at UC Santa Cruz (2009-2015), including California Geology (3x), Evolution of the Earth System (2x)
- Organized and led Yale graduate reading groups on a) sedimentary records of silica burial through earth history and b) the Middle Eocene Climatic Optimum and c) Neoproterozoic glaciations
- External Ph.D. defense committee member, Dr. Shelbie Legett, SUNY Stony Brook (2019)
- Guest lecturer in Yale graduate and undergraduate classes (2016-2019), designed and led carbon cycle modeling exercises for graduate class
- Mentored undergraduate theses of Christine Baba (UCSC 2014), Chris Bowman (Yale 2016), Mahima Kumara (Yale, in progress), and Madison Shankle (2019)

Professional Involvement

- Co-convenor, 2018 AGU Session PP-015: Evolution of the marine silica cycle
- Editorial Board, IODP Expedition 371 Expedition Report and Site Chapters, January 2018
- Proponent, IODP Drilling proposal 917: "Revisiting the Mesozoic to Pleistocene in the Southeastern Gulf of Mexico: Plate Tectonics, Ocean Circulation, and Climatic Evolution" submitted April 2017 and selected to be developed into full drilling proposal
- Manuscript peer reviewer for *Nature*, *Nature Geoscience* (3x), *Geology* (7x), *EPSL* (5x), *Paleoceanography (& Paleoclimatology)* (5x), *GCA*, *G³*, *P³*, *Geophysical Research Letters*, *Chemical Geology*, *Climate of the Past*, *Rapid Communications in Mass Spectrometry*, and several others
- NSF proposal reviewer (P2C2 program, CAREER program)
- European Research Council proposal reviewer

Selected workshops and short courses

- MagellanPlus drilling proposal workshop: The North Atlantic Igneous Province continental break-up magmatism and impacts on global warming during the Paleogene," Kiel (2018)
- Australasian IODP regional planning workshop (2017)
- IODP workshop: "Demystifying the IODP proposal process for early career scientists," University of Texas Austin (2017)
- Friends of the PETM workshop at Arizona State University (2016)
- Paleo-CO₂ proxy development workshop, Santa Cruz, (Co-convenor with Gavin Foster and Eleni Anagnostou, 2014)

- Cenozoic History of the CCD, organized by Andy Ridgwell, Santa Cruz (2012)
- cGENIE Earth Systems modeling summer workshop, Santa Cruz led by Andy Ridgwell (2012)
- Boron week at NOCS: Training in $\delta^{11}\text{B}$ analysis by MC-ICPMS with Gavin Foster, University of Southampton (2011)
- Urbino Summer School in Paleoclimatology, Urbino Italy (2010)

Selected conference presentations (* = presenter)

- *A coupled carbon and silica cycle perturbation during the Marinoan snowball Earth, **Penman, D.E.**, Rooney, A. R., 2019 Northeast Geobiology meeting (talk).
- *Contrasting the Response of Marine Calcifiers and Silicifiers during Carbon Cycle Catastrophes, **Penman, D.E.**, Hull, P.M., Ridgwell, A., 2018 Goldschmidt Conference. Interactions between tectonics, silicate weathering, and climate explored with carbon cycle modeling, **Penman, D.E.**, *Caves, J.K., Ibarra, D.E., Winnick, M.J., AGU Fall Meeting 2017 (invited talk)
- *New records of the global weathering response to the PETM from the North Atlantic, **Penman, D.E.**, AGU Fall Meeting 2016 (invited talk)
- *Hyperthermal-associated North Atlantic silica burial throughout the Lower Eocene (talk), **Penman, D.E.**, Hull, P., Kirtland Turner, S., Keller, A., D'Haenens, S., Goldschmidt Conference 2016
- *Global Ocean acidification during the PETM: new records from the Southern Ocean and NJ Margin, **Penman, D.E.**, Babila, T., Kelly, D. C., Rosenthal, Y., Bralower, T. J., Zachos, J. C., GSA Annual Meeting 2015
- *New insights into PETM recovery processes from Expedition 342 sediments, **Penman, D. E.**, IODP Expedition 342 Post-cruise Science Meeting (Talk)
- *Silicate weathering and North Atlantic chert deposition during the Paleocene-Eocene Thermal Maximum, **Penman, D. E.**, AGU Fall Meeting 2015
- *Direct evidence for CCD over-compensation in the aftermath of the PETM (talk), **Penman, D.E.**, Kirtland-Turner, S., Sexton, P., Cameron, A., Boulila, S., Norris, R.D., Zachos, J.C., Röhl, U., Westerhold, T., IODP Exp. 342 Scientists. AGU Fall Meeting 2013
- *B/Ca of planktic foraminifera documents ocean acidification during the Paleocene-Eocene Thermal Maximum (talk), **Penman, D.E.**, Zachos, J.C., Hönisch, B., Zeebe, R.E., Bohaty, S. at 2011 AGU Fall Meeting 2011
- *Boron proxy evidence for surface ocean acidification & higher pCO_2 during the PETM (talk) **Penman, D. E.**, Zachos, J.C., Hönisch, B., Eggins, S., Zeebe, R.E. (2011) at Climate and Biota of the Early Paleogene conference in Salzburg

Popular Press Coverage

- New evidence of a long-term planetary thermostat to remove excess CO_2 (press release for Penman et al., 2016, *Nature Geoscience*)
<http://news.yale.edu/2016/07/25/new-evidence-long-term-planetary-thermostat-remove-excess-co2>
- Modern Ocean Acidification Is Outpacing Ancient Upheaval, Study Suggests (coverage of Penman et al., 2014, *Paleoceanography*)
<http://www.ldeo.columbia.edu/news-events/modern-ocean-acidification-outpacing-ancient-upheaval-study-suggests> covered by Science Daily, Discover News, Phys.org, Vice News, etc.
- Penman et al. (2014), *Paleoceanography* is listed by AltMetric (aggregator of press coverage) as the highest-scoring article ever in *Paleoceanography*:
http://www.altmetric.com/details.php?domain=onlinelibrary.wiley.com&citation_id=2297530

