

CURRICULUM VITAE

Scott David Wankel

Stable isotope biogeochemist
Associate Scientist w/o tenure
Department of Marine Chemistry and Geochemistry
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EDUCATION

B.S. in Geology, June 1996

Furman University

B.A. in German Literature, June 1996

Greenville, So. Carolina, USA

Master of Environmental Science, October 2000

Miami University

Institute of Environmental Science

Oxford, Ohio USA

Areas of Concentration: Water Resources, Environmental Geology

PhD, January 2007

Stanford University

Dept of Geological and Environmental Sciences

Stanford, California USA

Dissertation Title: Nitrate sources and cycling in coastal ecosystems:

Insights from a nitrogen and oxygen stable isotope approach

PROFESSIONAL EXPERIENCE

2016 – present	Associate Scientist w/o tenure, Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA
2012 – 2016	Assistant Scientist, Dept. of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA
2010 – 2012	Research Associate, Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA
2009 – 2010	Research Associate, Department of Organismal and Evolutionary Biology, Harvard University, Cambridge, MA
2007 – 2009	Postdoctoral Scientist, Department of Organismal and Evolutionary Biology, Harvard University, Cambridge, MA
2000 – 2007	Stable Isotope Biogeochemist, Water Resources Division, United States Geological Survey, Menlo Park, CA

HONORS and AWARDS

2018 - 2019	Institute for Advanced Studies – Hansewissenschaftskolleg (HWK) Fellowship (Aug 2018 – May 2019)
2016	CLISAP Fellowship – University of Hamburg
2003 - 2006	National Oceanic and Atmospheric Administration (NOAA) National Estuarine Research Reserve Graduate Fellowship
2003 - 2006	US Geological Survey Service Award (2003, 2004, 2005, 2006)
2006	Shell Foundation Grant Award, Stanford University

2005 Best Student Presentation - Applied Isotope Geochemistry VI Prague, Czech Rep.
 2005 Significant Processes, Observations and Transformations of Oceanic Nitrogen (SPOT-ON) Student Travel Scholarship
 2003 Shell Foundation Grant Award, Stanford University
 2002 McGee Fund Research Grant, Stanford University School of Earth Sciences
 2001 Shell Foundation Grant Award, Stanford University
 1998 Outstanding Student Award, Institute of Environmental Sciences, Miami University
 1998 Institute of Environmental Sciences, Comp. Exam Honors, Miami University
 1997 Carl Duisberg Society Scholar, Cologne, Germany
 1996 Fallaw Outstanding Senior Award, Geology, Furman University
 1992 Eagle Scout, Troop 695

PROFESSIONAL AFFILIATIONS

2008- present Geochemical Society
 2000–present American Geophysical Union
 2000- present American Society of Limnology and Oceanography

RESEARCH INTERESTS

- Stable isotope biogeochemistry
- Nitrogen cycling
- Biogeochemistry of coastal/estuarine systems
- Production and cycling of climatically active gases, especially methane and nitrous oxide
- Coupling of elemental cycling, especially nitrogen, iron, carbon, manganese and sulfur
- Deep biosphere and deep-sea biogeochemistry
- In situ biogeochemical sensor development, especially for stable isotope analysis

PROFESSIONAL ACTIVITIES

WHOI

- Review Panelist for Internal Awards (2017)
- Faculty Search Committee MC&G (2016)
- Faculty Host for Steinbach Scholar MC&G (Bess Ward, 2015)
- Participant in Raytheon visit to WHOI and Center for Marine Robotics (2014)
- MIT/WHOI Joint Program faculty meeting presentation (Nov 2014)

EXTERNAL

- FUSE Workshop Participant, Northeastern University, June, 2018
- Invited participant of Workshop on “Reading Terrestrial Planet Evolution in Isotopes and Elemental Measurements” at the International Space Science Institute (Bern, Switzerland – Oct 22-26, 2018).
- Collaborator MARUM Center for Excellence (Ocean Floor Processes), Marcus Elvert
- Invited Guest Researcher at the Helmholtz Center for Coastal Research, Geesthacht, Germany (2 weeks, May, 2016)
- Participant – 2016 Gordon Research Conference on Gas Hydrates, Galveston, TX

- Invited NSF Workshop participant (Jan 2016): Deep Submergence Science in the Next Decade (DESCEND-2), Cambridge, MA; Biogeochemistry group co-leader
- Invited NASA Panelist (2015, 2016, 2017 (NAI 8))
- Invited participant, Workshop on Cavity Enhanced Optical Detection Schemes, GEOMAR, Kiel, Germany (2015)
- Invited NSF Panelist (2015)
- Developed and conducted 2-day workshop at Waquoit Bay National Estuarine Research Reserve on Nitrogen cycling in watersheds for high school science and math teachers (2014, 2015, 2016)
- Invited participant C-DEBI Theme Team Workshop – San Pedro, CA (2013)
- Planning committee member and instructor, UNOLS DESSC Early Career Workshop, San Francisco, CA (2012, 2013)
- Review Editor, *Frontiers in Aquatic Microbiology* (2010-present)
- Session organizer/convener for Goldschmidt Conference (2009, 2012, 2016, 2017), AGU (2014, 2016)
- **Manuscript Reviewer** for: ACS Earth and Space Chemistry, *Geochimica et Cosmochimica Acta*, *Environmental Science and Technology*, *Nature*, *Analytical Chemistry*, *Biogeosciences*, *Nature Geoscience*, *Environmental Microbiology*, *Applied and Environmental Microbiology*, *Marine Chemistry*, *Geobiology*, *Geophysical Research Letters*, *Journal of Geophysical Research*, *Atmospheric Physics and Chemistry*, *Limnology and Oceanography*, *Rapid Communications in Mass Spectrometry*, *Science Advances*, *European Journal of Soil Science*
- **Proposal Reviewer** for: NSF-EAR Low Temperature Geochemistry and Geobiology, NSF-OCE Chemical Oceanography, NSF-OCE Biological Oceanography, NSF-DEB Dimensions of Biodiversity, NSF-PLR Antarctic Organisms and Ecosystems, NSF-OCE Ocean Technology and Interdisciplinary Coordination, NSF-EAR Instruments and Facilities, NSF-OCE Research Initiation Grants, NASA Exobiology, NASA Astrobiology Institutes, Israel Science Foundation, NOAA-Office of Atmospheric Research

PARTICIPATION IN EDUCATION

Postdoctoral Researchers

- Dalton Hardisty (WHOI Postdoc Scholar MG&G w/ S. Nielsen, co-advised)
- Carolyn Buchwald (Postdoctoral Fellow, 2012-2016)

Graduate Student Advisees

- Chawalit Charoenpong (MIT/WHOI JP Student MC&G, 2013-present)
- Kevin Sutherland (MIT/WHOI JP Student MC&G, 2014-present)
- Evan Howard (MIT/WHOI JP Student MC&G, 2014-2016), PhD
- Jennifer Karolewski (MIT/WHOI JP Student MC&G 2016-present)
- Advisor for MIT/WHOI JP Chemical Oceanography, Entering Class of 2012

Undergraduate/Guest Students

- Alexander Bratek (guest student, University of Hamburg, Fall, 2017)
- Noah Gluschankoff (WHOI Summer Student Fellow, Summer 2017)

- Brooke Rasina (WHOI Summer Student Fellow, with K. Hughen, Summer 2017)
- Kira Homola (guest student, University of Rhode Island, Summer 2017)
- Jaimie Keeping (guest student, Dalhousie University, Summer 2017)
- Margot White (guest student, Scripps Institution of Oceanography, Summer 2016)
- Daniel Diaz-Etchevehere (WHOI Summer Student Fellow, Summer 2015)
- Lucas Melas-Kyriazi (guest student, Summer 2015)
- Anna-Neva Visser (guest student, University of Tübingen, Summer 2014)
- Kalina Grabb (guest student, Harvard University, Summer 2014)
- Emily Chua (WHOI Summer Student Fellow, with Anna Michel, Summer 2014)

Thesis committee member:

- Emily Estes (MIT/WHOI, 2014-2016; advisor Colleen Hansel) Jan 2017, PhD
- Evan Howard (MIT/WHOI, 2012-2014; advisor Rachel Stanley) Dec 2016, PhD
- Andrew Johnson, US Navy (MIT/WHOI, 2017-2019; advisor Anna Michel) MS

Thesis Committee Member (outside WHOI)

- Kyra Kim (University of Delaware, advisor Drs. William Ullman and Holly Simon)
- Anna-Neva Visser (University of Tübingen, advisor Dr. Andreas Kappler)
- Thomas Creech (University of Alabama, advisor Dr. Rona Donahoe)

PhD Defense Chair:

- Jill McDermott (MIT/WHOI, 2014; advisor Jeff Seewald, Sep 2014, PhD)
- Rene Boiteau (MIT/WHOI, 2016; advisor Dan Repeta, Jan 2016, PhD)

Instructor, WHOI

- MC&G Seminar ‘Landmark Papers in Chemical Oceanography’ (2016, 2018)

Guest Lecturer, Harvard University

- 2011 Soil and Environmental Chemistry: Nitrogen Cycling in the Environment
- 2011 Water Science Technology: Nitrification, Denitrification and Anammox
- 2010 Biogeochemistry: The Global Nitrogen Cycle
- 2010 Stable Isotope Geochemistry: Marine Nitrogen Biogeochemistry
- 2008 Environmental Microbiology: Microbial Nitrogen Cycling

SUPERVISION AT WHOI

Technical Staff

- Matt Erickson (Research Associate II, 2012-2013)
- Zoe Sandwith (Research Assistant III, 2013-present)

CRUISE AND FIELDWORK PARTICIPATION

- ***R/V Falkor. Cascadia Margin, Astoria Canyon and Hydrate Ridge. Co-chief Scientist. Aug 24 – Sep 20, 2018.***

Co-lead cruise award application, cruise planning, mobilization and scientific operations (w/ A. Michel, WHOI) for investigation of the fate of bubble-hosted methane release from the seafloor. Served as lead interface with instrument integration and daily operations with ROV *SuBastian*. Supervised and/or lead geochemical investigations including: In situ analyses of bubble composition (via in situ mass spectrometer) and methane isotopic composition (via in situ laser spectrometer), experimental incubations of anaerobic methane oxidation in sediments facilitated by sulfate, iron and manganese reduction, and water column chemistry. Complementary scientific activities included high-speed stereo-camera imaging of rising bubbles, characterization of microbial community composition, and collection and analyses of mobile, benthic macrofauna, sea-surface mapping of methane using autonomous ‘ChemYak’ and deployment of an autonomous benthic lander for biogeochemistry (ABISS).
- ***R/V Robert Gordon Sproul. Santa Barbara Basin, CA. Scientist. Apr 30 – May 8, 2018.***

Measurement of porewater and water column dissolved inorganic nitrogen and iron species in relation to benthic foraminifera communities. Sediment collection by multi-corer and box-coring. Porewater extraction and analyses of dissolved iron and nitrogen.
- ***E/V Nautilus. Pescadero Basin, Gulf of California, Mexico. Co-chief Scientist. Oct 30 – Nov 7, 2017.***

Co-lead cruise planning, mobilization and operations with A. Michel (WHOI). Conducted chemical and isotopic exploration of newly discovered hydrothermal system using in situ mass spectrometry and laser spectroscopy. Collected water column samples for nitrogen speciation and isotopic analyses, transformation rate measurements, for DNA/RNA analyses for microbial community and activity and for ammonia-oxidation rate measurements.
- ***E/V Nautilus. Guaymas Basin North, Gulf of California, Mexico. Scientist. Oct 18-28, 2017.***

Conducted chemical and isotopic exploration of newly discovered hydrothermal system using in situ mass spectrometry and laser spectroscopy. Collected water column samples for nitrogen speciation and isotopic measurements, for DNA/RNA analyses for microbial community and activity and for ammonia-oxidation rate measurements.
- ***E/V Nautilus. Autonomous Benthic Instrument for In Situ Studies (ABISS 1). Co-PI. Jul 30 – Aug 3. California Coast.***

Lead mobilization of first-time deployment of *in situ* mass spectrometer and laser spectrometer for study of benthic carbon cycling at large seep sites. Participated in cruise activities via telepresence.
- ***R/V Endeavor. Transient oxygen radicals in the cycling of Hg (TORCH). Scientist. Aug 28 – Sep 9, 2016. New England Shelf.***

Investigation of the primary nitrite maximum in shelf water settings. Collection of samples for isotopic analysis. Incubation experiments for nitrite production/consumption rates. Pilot assessment of isotopic method for atmospheric nitrate quantification.

- ***E/V Nautilus*. Gulf of Mexico Brine Pools (GoMEX). Chief Scientist. May 11-19, 2015. Galveston, TX.**
Chemical and isotopic characterization of a deep-sea brine pool/mud volcano using in situ laser spectroscopy. Two ROV dives (*Hercules*), collecting fluid samples and measuring carbon isotopic composition of methane and carbon dioxide.
- ***E/V Nautilus*. Kick'em Jenny Volcano and Barbados Mud Volcanoes (TREET). Shipboard scientist. Sep-Oct 2014.**
Chemical and isotopic exploration of hydrothermal fluids from an active submarine volcano using in situ laser spectroscopy. Two ROV dives (*Hercules*), collecting fluids and measured chemical composition of gases in hydrothermal fluids and bubbles.
- **Coastal N₂O biogeochemistry. Project Lead. Jan 2014. Santa Catalina Island, CA**
Investigation of N₂O dynamics at the coastal sediment-water interface. Conducted 24 intact flow-through sediment core incubations – regularly sampling for stable isotopes of NO₃⁻, NO₂⁻, NH₄⁺, and N₂O. Microsensor profiling, porewater extractions.
- **Coastal N₂O biogeochemistry. Project Lead. Aug 2013. Island of Sylt, Germany**
Investigation of N₂O dynamics at the coastal sediment-water interface. Conducted 24 intact flow-through sediment core incubations – regularly sampling for stable isotopes of NO₃⁻, NO₂⁻, NH₄⁺, and N₂O. Microsensor profiling, porewater extractions.
- ***R/V Point Lobos*. Chief Scientist. 2008 – 2009 (4 cruises). Monterey Bay, CA**
Test dives for development of *in situ* laser spectrometer (ICOS). *In situ* profiling of sediment porewater methane isotopes. Instrument deployment, survey of methane concentration and stable isotopic composition at cold seep environments. Sediment pushcore collection.
- ***R/V Atlantis*. Research Scientist. 2007 – 2008 (2 cruises). Juan de Fuca Ridge, Canada**
Survey of volatile composition in vent fluids with *in situ* mass spectrometer. Collection of animal and microbial mat samples. Use of gas-tight and major samplers for dissolved isotopic and geochemical analyses. Collection of animal, microbial mat and sediment pushcore samples.
- ***R/V Polaris*. Research Scientist. Jul-Aug 2004 (3 cruises). San Francisco Bay, CA**
Regional Monitoring Program collecting water and sediment samples for isotopic, geochemical and microbial analyses.
- ***R/V Point Lobos*. Research Scientist. 2002 – 2006 (12 cruises). Monterey Bay, CA**
Monthly Surface Water Survey CTD casts. Sampling for nitrate isotope analyses.

PAPERS IN REFEREED JOURNALS AND BOOKS: (*lab member; corresponding author)

Manuscripts in preparation (project is mostly complete):

Carly Buchwald and **SD Wankel**. Nitrate reduction by nitrite oxidizing bacteria: Implications for nitrogen cycling and isotope budgets of global oxygen deficient zones.

Wankel, SD, APM Michel, J McDermott, R Zierenberg and AS Soule. Geochemical investigation of hydrothermal venting in the Pescadero Basin, Mexico.

Karolewski*, JS, KM Sutherland*, CM Hansel and **SD Wankel**. Abiotic NO₂⁻ oxidation by ligand-bound manganese (III): An isotopic investigation.

Sutherland*, KM, **SD Wankel** and CM Hansel. New perspectives on marine ferromanganese crust formation and evolution: Interrogating textural, mineralogical and isotopic composition.

Draft Manuscripts in circulation (Drafts are actively being circulated among co-authors)

Long, MH, KM Sutherland*, **SD Wankel**, DJ Burdige, and RC Zimmerman. Quantifying ebullition of oxygen from seagrass under super-saturated conditions. (Target Journal: *MEPS*)

Grabb, K, **SD Wankel**, A Apprill, J Kapit, K Manganini and CM Hansel. A diver operated submersible chemiluminescent sensor (DISCO) for coral reef studies of reactive oxygen species associated with coral health. (Target Journal: *ES&T*)

Bratek A, J Möbius, T Sanders, K Dähnke, **SD Wankel**, and KC Emeis. Nitrate sources and dynamics in the catchment basin of the Rhône River. (Target Journal: *ES&T*)

Charoenpong*, C, JS Seewald, and **SD Wankel**. Isotopic insights into the fate of nitrate under hydrothermal conditions and its implications for N budgets in seafloor systems. (Target Journal: *GCA*)

Sutherland*, KM, **SD Wankel** and CM Hansel. Insights into oxygen turnover in the global ocean: A global budget of extracellular superoxide. (Target Journal: *Nature*)

White, M, PA Rafter, BM Stephens, DM Sigman, **SD Wankel** and L Aluwihare. Recent increases in water column denitrification in the seasonally anoxic bottom waters of the Santa Barbara Basin (Target Journal: *GRL*)

Stephens, BM, **SD Wankel**, JM Beman, A Rabines, AE Allen, and LI Aluwihare. Euphotic Zone Nitrification in the California Current Ecosystem. (Target Journal: *GBC*)

Orsi WD, **SD Wankel**, ÖK Coskun, T Magrithsch, A Vuillemin, ER Estes, AJ Spivack, DC Smith, R Pockalny, RW Murray and S D'Hondt. DNA replication and growth by microbial communities from ancient abyssal clay. In revision.

Developed idea for application of ¹⁸O-SIP to quantifying deep biosphere microbial activity. Designed incubation experiments with WDO and supplied materials for incubations conducted in Wankel Lab at WHOI. Discussed data and interpretation with co-authors. Assisted with manuscript writing and editing.

Elliott EM, C Kendall, B Boyer, DA Burns, DJ Bain, JD Felix, **SD Wankel**, and K Harlin. Stable isotopes reveal NO_x source contributions to nitrate deposition in the continental United States. In revision.

Developed project concept and original proposal. Co-supervised dual isotopic analyses of >800 atmospheric nitrate samples with Elliott at USGS. Provided feedback on analytical quality control and data interpretation. Gave feedback on manuscript.

Smart C, C Roman, APM Michel and **SD Wankel**. Remote Detection of Density Anomalies Within Gulf of Mexico Brine Pools using a High Resolution Multibeam Sonar System. In revision.

Served as co-chief scientist on research cruise (with A. Michel, WHOI), coordinating all science operations during cruise. Designed and implemented ROV-operated CTD profiler and fluid sample delivery system for deep-sea laser spectrometer.

Babbin AR, C Buchwald*, FMM Morel, **SD Wankel**, BB Ward. In review. Anaerobic nitrite oxidation, a major nitrogen cycle pathway in the oxygen deficient zones of the ocean. In revision.

Supervised all nitrogen isotopic analyses for nitrite oxidation rate measurements made in the Wankel lab at WHOI. Discussed results and provided insight on data interpretation. Provided editorial feedback on manuscript.

Manuscripts in Review/Revision:

[42] Hardisty, DS, TJ Horner, **SD Wankel**, J Blusztajn and SG Nielsen. Experimental observations of marine iodide oxidation. In review: *GCA*.

Assisted postdoc lead-author with experimental design and interpretation of results. Some incubations carried out in Wankel lab at WHOI. Contributed comments on manuscript drafts.

[41] Estes ER, R Pockalny, S D'Hondt, F Inagaki, Y Morono, RW Murray, D Nordlund, AJ Spivack, **SD Wankel**, N Xiao, and CM Hansel. Spectroscopic windows in to the persistence of organic carbon in oxygenated marine sediment. In revision. *Nature Geoscience*.

Contributed to measurements of organic carbon and nitrogen. Participated in extended interpretative discussions. Commented on several draft manuscripts.

[40] Nicholson, D, APM Michel, **SD Wankel**, K Manganini, R Sugrue, Z Sandwith* and S Monk. Rapid mapping of methane and carbon dioxide in coastal ecosystems using the ChemYak, an autonomous surface vehicle. In revision: *ES&T*.

Co-lead development, validation and first deployments of the ChemYak (w/ A. Michel and D. Nicholson, WHOI). Provided several rounds of edits and comments on draft manuscript.

Manuscripts Published or Accepted:

[39] Buchwald*, C, K Homola, AJ Spivack, ER Estes, RA Pockalny, RW Murray and **SD Wankel**. Isotopic constraints on nitrogen transformation rates in the deep sedimentary marine biosphere. Accepted. *Global Biogeochemical Cycles*.

All analyses, modeling and interpretation were carried out in the Wankel lab at WHOI. CB and SDW wrote the paper with input from other associated authors.

[38] Shen, J, A Pearson, G Henkes, Y Zhang, K Chen, **SD Wankel** and Y Shen. Improved efficiency of the biological pump as a trigger for the late Ordovician Glaciation. 2018. *Nature Geoscience*. **11**:510-514.

Supervised analyses of all nitrogen isotope measurements and porphyrin-derived N concentrations, all which were conducted in the Wankel lab at WHOI. Gave editorial feedback on manuscript.

[37] Sutherland*, KM, **SD Wankel** and CM Hansel. 2018. Oxygen isotope analysis of bacterial and fungal manganese oxides. *Geobiology*. doi: 10.1111/gbi.12288.

[36] Michel APM, **SD Wankel**, J Kapit, Z Sandwith*, PR Girguis. 2017. In situ carbon isotopic exploration of an active submarine volcano. *Deep Sea Research, Part II*. 150:57-66. doi: 10.1016/j.dsr2.2017.10.004

[35] **Wankel, SD**, A Bourbonnais and C Charoenpong*. 2017. Microbial nitrogen cycling processes in submarine hydrothermal vents. In *Life in Extreme Environments*, J Kallmeyer (Ed). pp 179-209.

[34] **Wankel SD**, W Ziebis, C Buchwald*, C Charoenpong*, D de Beer, J Dentinger, Z Xu, K Zengler. 2017. Evidence for non-traditional N₂O formation pathways in nitrogen-impacted coastal ecosystems: fungal and chemodenitrification. *Nature Communications*. doi: 10.1038/NCOMMS15595.

[33] Sylvan J, **SD Wankel**, DE LaRowe, C Charoenpong*, JA Huber, CL Moyer and KJ Edwards. 2017. Microbes mediate subseafloor nitrogen redox processes a Loihi Seamount, Hawaii. *Geochimica et Cosmochimica Acta*. 198:131-150.

Conducted all nitrogen stable isotopic measurements and interpretation. Discussed results of geochemistry, thermodynamic modeling and isotopic analyses and co-wrote paper with Sylvan and LaRowe.

[32] Grabb*, KC, C Buchwald*, CM Hansel, and **SD Wankel**. 2017. A dual nitrite isotopic investigation of chemodenitrification by mineral-associated Fe(II) and its production of nitrous oxide *Geochimica et Cosmochimica Acta*. 196:388-402.

[31] **Granger J**, and **SD Wankel**. 2016. Isotopic overprinting of nitrification on denitrification as a ubiquitous and unifying feature of environmental nitrogen cycling. *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1601383113.

[30] Hurley, SJ, FJ Elling, M Könneke, C Buchwald*, **SD Wankel**, AE Santoro, JS Lipp, K-U Hinrichs and A Pearson. 2016. Nitrification rate is a fundamental control on archaeal lipid composition and the TEX₈₆ proxy. *Proceedings of the National Academy of Sciences*. 113:7762-7767.

Supported postdoc Buchwald in joining research cruise. Nitrification rate samples were analyzed under my supervision at WHOI. Edited and gave feedback on manuscript.

[29] Estes, ER, PF Andeer, D Nordlund, **SD Wankel** and CM Hansel. 2016. Biogenic manganese oxides as reservoirs of organic carbon and proteins in terrestrial and marine environments. *Geobiology*. doi:10.1111.gbi.12195.

Elemental and isotopic analysis of organic C and N was conducted under my supervision using instrumentation in my lab. Contributed to discussion and data interpretation. Edited and gave feedback on manuscript.

[28] Buchwald*, C, KC Grabb*, CM Hansel, and **SD Wankel**. 2016. Constraining the role of iron in environmental nitrogen transformations: Dual stable isotope systematics of abiotic NO₂⁻ reduction by Fe(II) and its production of N₂O. *Geochimica et Cosmochimica Acta* 186:1-12. doi:10.1016/j.gca.2016.04.041.

[27] **Wankel, SD**, C Buchwald*, W Ziebis, CB Wenk, and MF Lehmann. 2015. Nitrogen cycling in the deep sedimentary biosphere: Nitrate isotopes in porewaters underlying the oligotrophic North Atlantic. *Biogeosciences*. 12:7483-7502. doi:10.5194/bg-12-7483-2015.

[26] Hansel, CM, CJ Lentini, Y Tang, DT Johnston, **SD Wankel**, and PM Jardine. 2015. Dominance of sulfur-fueled iron oxide reduction in low sulfate freshwater environments. *The ISME Journal*. doi:10.1038/ismej.2015.50

Developed mass balance model and calculations for constraining ‘cryptic’ cycling pathways involving sulfur, carbon and iron intermediates; assisted in drafting figures and writing manuscript.

[25] **Wankel, SD**, AS Bradley, D Eldridge, and DT Johnston. 2014. Determination and application of the equilibrium oxygen isotope effect between water and sulfite. *Geochimica et Cosmochimica Acta*. 125:694-711. doi:10.1016/j.gca.2013.08.039.

[24] Liao, L, **SD Wankel**, M Wu, CM Cavanaugh and PR Girguis. 2014. Characterizing the plasticity of nitrogen metabolism by the host and symbionts of the hydrothermal vent chemoautotrophic symbioses *Ridgeia piscesae*. *Molecular Ecology*. **23**:1544-1557. doi:10.1111/mec.12460.

Analyzed nitrogen and oxygen isotopic composition of nitrate in tubeworm associated-fluids, (seawater and tubeworm blood). Used stable isotope data to constrain operative metabolic pathways in both host and symbiotic bacteria of tubeworm holobiont. Assisted in writing and editing of manuscript and drafting of figures involving isotope data.

[23] Orcutt, BN, DE LaRowe, JF Biddle, FS Colwell, BT Glazer, BK Reese, JB Kirkpatrick, LL Lapham, HJ Mills, JB Sylvan, **SD Wankel** and CG Wheat. 2013. Microbial activity in the deep biosphere: Progress and prospects. *Frontiers in Extreme Microbiology*. doi:10.3389/fmicb.2013.00189.

Invited participant of C-DEBI sponsored workshop aiming to identify gaps in understanding of microbial activity in the deep biosphere. Contributed as expert in metabolic cycling of nitrogen, hydrogen and methane. Manuscript synthesizes and summarizes major controls on and distribution of microbial metabolic activity across wide variety of seafloor environments, focusing on thermodynamic energy yields and prediction of major metabolic pathways sustaining life in deep biosphere.

[22] **Wankel, SD**, Y Huang, M Gupta, R Provencal, JB Leen, A Fahrland, C Vidoudez, and PR Girguis. 2013. Characterizing the distribution of methane sources and cycling in the deep sea via in situ stable isotope analysis. *Environmental Science and Technology*. **47**:1478-1486. doi:10.1021/es303661w.

[21] Lentini C, **SD Wankel** and CM Hansel. 2012. Linkages between carbon and iron biogeochemistry: Insights from a variety of iron oxide enrichment culturing. *Frontiers in Microbiology*. **3**:404 doi:10.3389/fmicb.2012.00404.

Analyzed organic acid concentrations in experiments, worked with co-authors to synthesize and interpret data in context of minerals and microbial communities. Wrote portions of manuscript, aided in drafting figures and editing final manuscript.

[20] **Wankel, SD**, MA Adams, DT Johnston, CM Hansel, SB Joye and PR Girguis. 2012. Anaerobic methane oxidation in metalliferous hydrothermal vent sediments: Influence of carbon flux and decoupling from sulfate reduction. *Environmental Microbiology*. doi:10.1111/j.1462-2920.2012.02825.x

[19] **Wankel, SD**, L Germanovich, M Lilley, G Genc, CJ DiPerna, AS Bradley, E Olson and PR Girguis. 2011. Influence of the subsurface biosphere on geochemical fluxes from diffuse hydrothermal fluids. *Nature Geoscience*. **4**:461-468.

[18] Learman DR, **SD Wankel**, SM Webb, N Martinez, AS Madden, and CM Hansel. 2011. Coupled Biotic-Abiotic Mn(II) Oxidation Pathway Mediates the Formation and Structural Evolution of Biogenic Mn Oxides. *Geochimica et Cosmochimica Acta*. **75**:6048-6063.

[17] Peterson JM, FU Zielinski, T Pape, R Siefert, C Moraru, R Amann, S Hourdez, PR Girguis, **SD Wankel**, V Barbe, E Pelletier, D Fink, C Borowski, and N Dubilier. 2011. A novel energy source for chemosynthetic symbioses: Hydrothermal vent mussels powered by hydrogen. *Nature*. **476**:176-180.

[16] **Wankel, SD**, A Mosier, CM Hansel, A Paytan, and CA Francis. 2011. Spatial variability in nitrification rates and ammonia-oxidizing microbial communities in the agriculturally impacted Elkhorn Slough estuary, CA. *Applied and Environmental Microbiology*. **77**(1):269-280.

- [15] **Wankel, SD**, SB Joye, VA Samarkin, SR Shah, G Friederich, J Melas-Kyriazi, and PR Girguis. 2010. New constraints on methane fluxes and rates of anaerobic methane oxidation in a Gulf of Mexico brine pool via in situ mass spectrometry. *Deep Sea Research II*. **57**:2022-2029.
- [14] **Wankel, SD**, Y Chen, C Kendall, and A Paytan. 2010. Sources of aerosol nitrate to the Gulf of Aqaba: Evidence from $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of nitrate and trace metal chemistry. *Marine Chemistry*. **120**(1-4):90-99.
- [13] **Wankel, SD**, C Kendall, and A Paytan. 2009. Using nitrate dual isotopic composition ($\delta^{15}\text{N}$ and $\delta^{18}\text{O}$) as a tool for exploring sources and cycling of nitrate in an estuarine system: Elkhorn Slough, CA. *Journal of Geophysical Research – Biogeosciences*. **114**(G01011): 10.1029/2008JG000729.
- [12] **Wankel, SD**, A. Paytan, C. Kendall, TF Pennington, and F. Chavez. 2007. Nitrification in the euphotic zone as evidenced by nitrate dual isotopic composition: Observations from Monterey Bay, California. *Global Biogeochemical Cycles*. **21**(2): 10.1029/2006GB002723.
- [11] Derse E, K Knee, **SD Wankel**, C Kendall and A. Paytan. 2007. Identifying the sources of nitrogen to Hanalei Bay, Kauai utilizing the nitrogen isotope signature of macroalgae. *Environmental Science and Technology*. **41**(15): 5217-5223.
- [10] Elliott, EM, C Kendall, **SD Wankel**, EW Boyer, DA Burns, DJ Bain, K Harlin, TJ Butler, and R Carlton. 2007. An Isotopic Tracer of Stationary Source NO_x Emissions Across the Midwestern and Northeastern United States. *Environmental Science and Technology*. **41**(22): 7661-7667.
- [9] Ewing SA, GM Michalski, M Thiemens, RC Quinn, JL Macalady, S Kohl, **SD Wankel**, C Kendall, CP McKay, and R Amundson. 2007. The rainfall limit of the nitrogen cycle on earth. *Global Biogeochemical Cycles*. **21**(3): 10.1029/2006GB002838.
- [8] Kendall, C, EM Elliott and **SD Wankel**. 2007. Tracing anthropogenic sources of nitrogen to ecosystems. In *Stable Isotopes in Ecology and Environmental Science*. K Lajtha and RH Michener (eds.). Blackwell Scientific Publications, Oxford.
- [7] Leichter, JL, A Paytan, **SD Wankel**, K Hanson, S Miller, and M Altabet. 2007. Nitrogen and oxygen isotopic signatures of subsurface nitrate: Evidence of deep water nutrient sources to the Florida Keys reef tract. *Limnology and Oceanography*. **52**:1258-1267.
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- [4] Chang, C, SR Silva, C Kendall, GM Michalski, KL Casciotti, and **SD Wankel**. 2005. Preparation and analysis of nitrogen-bearing compounds in water for stable isotope ratio measurement. In *Handbook of Stable Isotope Analytical Techniques*. PA de Groot (ed.). Chapter 15. Elsevier.
- [3] Paytan, A, F Martinez-Ruiz, M Eagle, A Ivy, and **SD Wankel**. 2004. Using sulfur isotopes to elucidate the origin of barite associated with high organic matter accumulation events in marine sediments in Amend JP, Edwards KJ, and Lyons TW eds. Sulfur Biogeochemistry – Past and Present. Boulder, Colorado, *Geological Society of America Special Paper 379*, p. 151-160.

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NON-REFEREED PUBLICATIONS

Michel, APM, **SD Wankel**, S Beaulieu, SA Soule, L Mullineaux, D Coleman, E Escobar-Briones, A Gaytan-Caballero, J McDermott, S Mills, D Speth and R Zierenberg. 2017. Biogeochemical exploration of the Pescadero Basin Vents. *Oceanography Supplement*, March 2017. 31(1):42-43.

Soule, AS, JS Seewald, **SD Wankel**, Anna PM Michel, R Beinart, E Escobar-Briones, E Morales-Dominguez, PR Girguis, D Coleman, NA Raineault, J Wagner, A Foulk, A Bagla and J Karson. 2017. Exploration of the Northern Guaymas Basin. *Oceanography Supplement*, March 2017. 31(1):39-41.

Cordes, EE, APM Michel, J Petersen, **SD Wankel**, R Ansorge, P Girguis, N Leisch, C Smart, C Roman, S Wetzel and C Vidoudez. 2016. ROV *Hercules* investigates brine lakes on the bottom of the ocean. *Oceanography Supplement*, March 2016. 29(1):p0-31.

Carey, S., R Ballard, KLC Bell, C Roman, F Dondin, R Robertson, J Gobin, **SD Wankel**, APM Michel, D Amon, L Marsh, C Smart, I Vaughn, B Ball, K Rodrigue, M Haldeman and A Jones. 2015. Exploring Kick'em Jenny submarine volcano and the Barbados Cold Seep Province in the southern Lesser Antilles. *Oceanography*. March 2015. 24(1):38-39.

INVITED PRESENTATIONS – SEMINARS

University of Pittsburgh, Department of Geology and Environmental Science Seminar. 2018. Tales from the deep: Bringing the biogeochemistry lab to the seafloor. Pittsburgh, PA.

University of Pittsburgh. Stable Isotope Working Group Seminar. 2018. Recent advances in stable isotopic modeling of microbially driven processes in the environment (with a focus on nitrogen transformations). Pittsburgh, PA.

University of Illinois, Urbana-Champaign. *Buckley Lecture in Environmental Geology.* 2017. Searching for signatures of abiotic reactions in natural systems: an isotopic look at chemodenitrification. Urbana-Champaign, IL.

University of Hamburg, Germany. 2016. New frontiers in geochemical sensors for marine studies of climatically active gases. Hamburg, Germany.

Helmholtz Center for Coastal Research. 2016. Trying to make sense of nitrogen isotope biogeochemistry: Multi isotope modeling. Geesthacht, Germany.

University of Hamburg, Germany. 2016. Coastal N₂O production in response to increased nitrogen loading: Overlooked contribution of fungal and chemodenitrification. Hamburg, Germany.

Marine Biological Laboratory. 2015. Disentangling the complexity of N₂O cycling in coastal sediments: A novel multi-isotope approach. Woods Hole, MA.

Bigelow Laboratory for Ocean Sciences. 2015. Bringing the isotope lab to the deep: Advances in deep-sea instrumentation for biogeochemistry. Boothbay, ME.

University of Massachusetts, Dartmouth (SMAST). 2015. Bringing the isotope lab to the deep: Advances in deep-sea instrumentation for biogeochemistry. New Bedford, MA.

Rutgers University. 2013. In situ measurements of volatile fluxes and stable isotopic composition: Linking biogeochemistry and microbial ecology in the deep sea. New Brunswick, NJ.

University of Connecticut. 2013. Linking biogeochemistry and microbial ecology in the deep subsurface: In situ measurement of volatile fluxes and stable isotopic composition. Groton, CT.

Washington University. 2013. Flying under the radar: Unrecognized complexity in the nitrogen cycle as revealed through multi-isotope studies. St. Louis, MO.

University of North Carolina. 2013. Isotope by isotope: Unraveling the complexity of marine N sources and cycling. Chapel Hill, NC.

Montana State University - Thermal Biology Institute. 2012. Linking biogeochemistry and microbial ecology in the deep subsurface: *In situ* measurement of volatile fluxes and stable isotopic composition. Bozeman, MT.

Boston Museum of Science. 2011. Earth Day Presentation. Microbes and Ocean Chemistry one year after the Deepwater Horizon spill: Microbes to the Rescue? Boston, MA.

Harvard University, Earth and Planetary Sciences – Departmental Seminar. 2011. From the light into the dark: New insights on biogeochemical cycles operating in both the surface ocean and deep-sea hydrothermal vents. Cambridge, MA.

Woods Hole Oceanographic Institution. 2011. Towards the intersection of geochemical, isotopic and microbial dynamics of nitrogen in marine systems. Woods Hole, MA.

Georgia Institute of Technology. 2011. From the light into the dark: Unraveling biogeochemical processes in marine nitrogen and carbon cycling. Atlanta, GA

Woods Hole Oceanographic Institution – Marine Chemistry and Geochemistry Seminar. 2010. From the light into the dark: New insights on surface ocean nitrogen cycling and volatile fluxes from the hydrothermal subsurface. Woods Hole, MA.

Miami University – Institute of Environmental Science Symposium. 2010. Application of environmental problem solving methodology to issues of global marine biogeochemistry. Oxford, OH.

MIT – Biogeochemistry Seminar. 2009. *In situ* integrated cavity optical spectroscopy (ICOS) at deep-sea hydrocarbon seeps: Real-time methane stable isotopic composition. Cambridge, MA.

Japanese Agency of Marine Science and Technology Seminar. 2009. Advances in deep-sea instrumentation: *In situ* mass spectrometry and integrated cavity optical spectroscopy at deep hydrothermal vents and hydrocarbon seeps. Tokyo, Japan.

United States Geological Survey 6th Annual Western Region Science Symposium. 2006. Frontiers in Nitrate Isotopes. Menlo Park, CA.

INVITED PRESENTATIONS – CONFERENCES

Annual ACS Meeting, 2018. Stable isotopic insights on redox connections in the cycling of nitrogen and metals. New Orleans, LA.

Goldschmidt Conference, 2017. Examining isotope signatures of chemodenitrification through a multi-isotope lens. Paris, France.

Annual ACS Meeting, 2017. Intricate coupling of carbon, nitrogen and iron redox cycling underlying the biogeochemical dynamics of N₂O. San Francisco, CA.

C-DEBI Annual Meeting. 2013. Nitrogen cycling in North Pond sediments: Isotopic constraints on rates of nitrification and denitrification. Marina, CA.

Goldschmidt Conference. 2013. Determination and application of the oxygen isotope equilibrium between sulfite and water. Florence, Italy.

Ecological Society of Japan, Annual Meeting. 2009. Dual nitrate isotopes as a tool for constraining nitrogen cycling process. Ecological Society of Japan, Annual Meeting. Morioka, Japan.

American Chemical Society National Meeting. 2007. Nitrification in the euphotic zone as evidenced by dual nitrate isotopic composition in Monterey Bay. Boston, MA.

VOLUNTEERED PRESENTATIONS AT CONFERENCES

OSM 2018. 2018. First-time combination of underwater sensors for carbon biogeochemistry in deep-sea environments. Portland, OR.

Gordon Conference on Gas Hydrates. 2016. Underwater isotopic analyses of methane using laser spectroscopy. Galveston, TX.

Northeastern Geobiology Symposium. 2016. Novel isotopic approaches to identifying non-traditional N₂O production mechanisms in coastal sediments. Harvard University, Cambridge, MA

OSM 2016. Coastal N₂O production in response to increased nitrogen loading: Overlooked contribution of fungal and chemodenitrification. New Orleans, LA.

OSM 2016. Chemical and Isotopic Exploration: A tale of two telepresence-enabled cruises. New Orleans, LA.

AGU Fall Meeting. 2014. Disentangling the complexity of N₂O cycling in coastal sediments: A novel multi-isotope approach. San Francisco, CA.

ASLO/Ocean Sciences. 2014. Imprint of the nitrogen cycle on deep subsurface autotrophy: Isotopic constraints on rates of nitrification and denitrification in sediments underlying the oligotrophic North Atlantic Ocean. Honolulu, HI.

DOE – Subsurface Biogeochemical Research Annual PI Meeting. 2013. Multi-isotope tools for understanding interactions of N cycling with Fe and U in the subsurface. Washington, DC.

AGU Fall Meeting. 2012. Is the dual isotopic composition of groundwater nitrate a recorder of interactions between N and Fe? San Francisco, CA.

DOE – Subsurface Biogeochemical Research Annual PI Meeting. 2012. Development of new and integrated stable isotope tools for understanding Nitrogen-Uranium interactions in subsurface environments. Washington, DC.

ASLO/AGU Ocean Sciences Meeting. 2012. *In situ* measurement of volatile concentrations and stable isotopic composition: Linking biogeochemistry and microbial ecology in the deep sea. Salt Lake City, Utah.

AGU Fall Meeting. 2011. Influence of the subsurface biosphere on geochemical fluxes from diffuse hydrothermal fluids. San Francisco, CA.

Goldschmidt Conference. 2011. In situ stable isotopic detection of anaerobic oxidation of methane in Monterey Bay cold seeps via integrated cavity output spectroscopy. Prague, Czech Republic.

Goldschmidt Conference. 2009. Advances in deep sea *in situ* instrumentation. Davos, Switzerland.

ASLO/AGU Ocean Sciences Meeting. 2008. Measurement of dissolved gases at Gulf of Mexico hydrocarbon seeps with the In Situ Mass Spectrometer. Orlando, FL.

ASLO/AGU Ocean Sciences Meeting. 2006. Temporal and spatial variability in denitrification rates as measured by isotope pairing in flow-through core incubations, Elkhorn Slough, CA. Honolulu, HI.

Applied Isotope Geochemistry VI. 2005. ^{17}O Anomalies in Atmospheric Nitrate: A Case Study in New England, USA. Prague, Czech Republic. **Awarded best student presentation.*

Significant Processes, Observations and Transformations of Oceanic Nitrogen (SPOT-ON). 2005. Nitrogen and Oxygen Isotopes of Nitrate as a Tracer of Nitrogen Sources and Cycling. Warnemünde, Germany.

AGU Fall Meeting. 2005. Nitrogen sources and cycling in the San Francisco Bay Estuary: A nitrate dual isotopic composition approach. San Francisco, CA.

AGU Fall Meeting. 2004. Nitrogen and Oxygen Isotopes of Nitrate – Indicators of Nitrogen Utilization in Monterey Bay, CA. San Francisco, CA.

Estuarine Research Federation Annual Meeting. 2003. New Stable Isotopic Techniques of Nitrate Applied to Investigation of Estuarine Nitrogen Cycling, Elkhorn Slough, CA. Seattle, WA.

AGU Fall Meeting. 2003. New Stable Isotopic Techniques of Nitrate Applied to Investigation of Estuarine Nitrogen Cycling, Elkhorn Slough, CA. San Francisco, CA.

ASLO/AGU Ocean Sciences Meeting. 2002. Exploring nitrogen sources in oligotrophic shallow water carbonate marine system using $\delta^{15}\text{N}$ of marine plants, San Salvador, Bahamas. Honolulu, HI.

Stable Isotope Ecology Annual Meeting. 2002. Bioaccumulation of Environmental Contaminants in Riverine Systems of the United States: Examination of the USGS Isotope Biomonitoring Project Datasets. Flagstaff, AZ.

AGU Fall Meeting. 2002. Quantifying Atmospheric Nitrate Loading to Watersheds Using Nitrate Isotopes ($\delta^{15}\text{N}$, $\Delta^{17}\text{O}$, $\delta^{18}\text{O}$). San Francisco, CA.

AGU Fall Meeting. 2001. Using $\delta^{15}\text{N}$ of marine plants to characterize nutrient sources and transport in an oligotrophic shallow-water marine system, San Salvador, Bahamas. San Francisco, CA.

STUDENT/POSTDOC PRESENTATIONS (*lab members)

Karolewski*, JS, KM Sutherland*, CM Hansel and **SD Wankel**. Exploring redox interactions between nitrogen and manganese: An isotopic study of nitrite oxidation by ligand-bound manganese (III). Northeastern Geobiology Symposium, 2018. Woods Hole, MA. Poster.

Sutherland*, KM, **SD Wankel** and CM Hansel. Constructing a global budget of marine superoxide production. Northeastern Geobiology Symposium, 2018. Woods Hole, MA. Oral.

Karolewski*, JS, KM Sutherland*, CM Hansel and **SD Wankel**. Exploring redox interactions between nitrogen and manganese: An isotopic study of nitrite oxidation by ligand-bound manganese (III). Ocean Sciences Meeting, 2018. Portland, OR. Poster.

Rasina*, B, **SD Wankel**, K Huguen, and C Charoenpong*. Nitrogen concentration and isotopic composition in coral cores from the Red Sea. Ocean Sciences Meeting, 2018. Portland, OR. Poster.

Gluschankoff*, N, C Charoenpong, J Karolewski, JS Seewald, and **SD Wankel**. Investigating reaction kinetics, products and isotope signatures during abiotic reduction of nitrite by amorphous iron sulfide. Ocean Sciences Meeting, 2018. Portland, OR. Poster.

Sutherland*, KM, **SD Wankel** and CM Hansel. 2017. Developing and interpretive framework for the oxygen isotope record in ferromanganese crusts. Goldschmidt Conference. Paris, France. Poster

Charoenpong*, C, **SD Wankel** and JS Seewald. 2017. Reaction kinetics and isotope fractionation during nitrate reduction to NH_4^+ under hydrothermal conditions. Goldschmidt Conference. Paris, France. Poster.

Buchwald*, C, K Homola, A Spivack and **SD Wankel**. 2016. Nitrogen cycling in oligotrophic deep-sea sediments: Insights from the $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of porewater nitrate and nitrite. Ocean Sciences Meeting. Honolulu, HI. Poster.

Sutherland*, KM, **SD Wankel**, and CM Hansel. 2016. Fingerprinting bacterial and fungal manganese oxidation via stable oxygen isotopes of manganese oxides. AGU Annual Meeting. San Francisco, CA. Oral.

Buchwald* C and **SD Wankel**. 2015. Deciphering nitrogen cycling in deep-sea sediments underlying the oligotrophic ocean: Insights from porewater nitrate isotopes, models and chemostats. Gordon Conference for Chemical Oceanography. Holderness, NH. Poster.

Charoenpong*, C, **SD Wankel** and JS Seewald. 2015. Tracking sources of ammonium from the Piccard and Von Damm hydrothermal vent fields. Gordon Conference for Chemical Oceanography. Holderness, NH. Poster.

Buchwald*, C, W Ziebis, MF Lehmann, CB Wenk and **SD Wankel**. 2014. Approaches to quantifying nitrogen cycling in North Pond sediments using N and O isotopes of nitrate. C-DEBI Annual Meeting, Marina, CA. Poster.

Charoenpong*, C, C Buchwald*, W Ziebis and **SD Wankel**. 2014. Nitrite isotope dynamics in coastal sediments: Intricate links between nitrogen and oxygen cycling. AGU Fall Meeting, San Francisco, CA. Poster.

Chua* E, APM Michel, **SD Wankel** and J Kapit. 2014. Improving an inlet for underwater volatile analyses. AGU Fall Meeting, San Francisco, CA. Poster.

Grabb*, KC, C Buchwald*, CM Hansel and **SD Wankel**. 2014. Stable isotope systematics of abiotic nitrite reduction coupled with anaerobic iron oxidation: The role of reduced clays and Fe-bearing minerals. AGU Fall Meeting, San Francisco, CA. Poster.

Buchwald*, C, CM Hansel, DT Johnston and **SD Wankel**. 2013. The ^{15}N and ^{18}O isotopic signature of abiotic nitrite reduction by iron (II). Goldschmidt Conference. Florence, Italy. Oral INVITED.