Ariel D. Anbar **January 2026**

President's Professor
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Biographical Summary

Ariel Anbar is a scientist and educator interested in Earth's past and future as an inhabited world, and the prospects for life beyond. His group develops novel geochemical methods to study topics ranging from the chemical evolution of the atmosphere and oceans to human disease. Trained as a geologist and a chemist, Anbar is a President's Professor at Arizona State University in the School of Earth & Space Exploration and the School of Molecular Sciences, and a Distinguished Global Futures Scientist in ASU's Global Futures Laboratory. Anbar directed ASU's Astrobiology Program from 2009 – 2015 and directs the Center for Education Through Exploration. A graduate of Harvard and Caltech, Anbar is author of >200 refereed papers. He is a Fellow of the American Geophysical Union, the Geological Society of America, the Geochemical Society and the European Association of Geochemistry, and is a Howard Hughes Medical Institute Professor. He is a recipient of the Donath Medal and the Arthur L. Day Medal of the Geological Society of America.

Education

1996	Ph.D.	(Geochemistry) California Institute of Technology, Pasadena, CA
1991	M.S.	(Geochemistry) California Institute of Technology, Pasadena, CA
1989	A.B.	(Geological Sciences and Chemistry) Harvard College, Cambridge, MA

Mentors

Graduate**:** G. J. Wasserburg & Y. L. Yung; Undergraduate: H. D. Holland

Professional Experience

2026 – present	Associate Director, Strategic and Faculty Development, ASU School of Earth & Space Exploration
2023 – 2026	Visiting Professorial Fellow, University of New South Wales, Sydney, Australia
2013 – present	President's Professor
2009 – 2013	Professor
2004 – 2009	Associate Professor School of Earth & Space Exploration (pre-2006, Dept. of Geological Sciences) School of Molecular Sciences (pre-2015, Dept. of Chemistry & Biochemistry) Arizona State University
2018 – present	Affiliated Faculty, ASU Mary Lou Fulton Teachers College
2015 – present	Director, ASU Center for Education Through Exploration
2015 – 2018	Co-Director, ASU PlanetWorks Initiative
2009 – 2015	Director, ASU Astrobiology Program
2012	Visiting Professor, Hebrew University, Jerusalem, Israel
2010 – 2011	Associate Director, ASU Origins Project
2021 – present	Distinguished Global Futures Scientist, ASU Global Futures Laboratory
2014 – 2021	Distinguished Sustainability Scientist, ASU Global Institute of Sustainability
2010 – 2014	Senior Sustainability Scientist, ASU Global Institute of Sustainability
2002 – 2004	Associate Professor
1996 – 2002	Assistant Professor

Dept. of Earth & Environmental Sciences and Dept. of Chemistry
University of Rochester

Career Achievement Summary

- >210 peer-reviewed papers (> 20 first author; > 80 led by student or postdoc supervisees)
- > 29,000 citations; 42 papers with > 200 citations; h-index 89 (*Google Scholar*)
- > 25 publications in *Science* or *Nature* journals (incl. 2 letter-to-editor & 2 reply-to-comment)
- > 400 conference abstracts
- > 165 invited presentations/colloquia at universities
- > 45 invited conference presentations (e.g., AGU, GSA, Goldschmidt)
- 16 invited book chapters, reports, reviews, white papers
- 6 invited oral presentations at Gordon Research Conferences
- PI of > $55 million in cumulative awards
- Major NASA and NSF grant awards include:
  - PI of NASA Exploration Connection project: $10.2M, 2016 – 2021; $10.8M, 2021 – 2026
  - PI of NSF Frontiers in Earth System Dynamics "Early O_2" Team: $5M, 2013 – 2019
  - PI of NASA Astrobiology Institute Team "Follow the Elements": $6.5M, 2009 – 2015
- Primary supervisor of 16 Ph.D. students, 11 M.S. students, 2 in progress
- Primary supervisor of 17 postdocs
- Significant service includes:
  - Co-Editor-in-Chief, Treatise on Geochemistry (Elsevier), 2020 – 2025
  - President-Elect, President, Past-President, AGU Biogeosciences Section, 2015 – 2020
  - Director, ASU Center for Education Through Exploration, 2015 – present
  - Co-Chair, 2010 Gordon Research Conference on Environmental Bioinorganic Chemistry
  - Chair, Science Steering Committee, 2008 Astrobiology Science Conference
  - Co-Chair, NASA Astrobiology Inst. Deep Time Drilling Project, 2002 – 2008
- Notable recognition includes:
  - Carl Sagan Lecture, AGU, 2022
  - Fellow, American Geophysical Union, 2021
  - Arthur L. Day Medal, Geological Society of America, 2020
  - Science Innovation Award, European Association of Geochemistry, 2019
  - ASU Alumni Association Founders Day Teaching Achievement Award, 2018
  - Named one of 10 "teaching innovators", Chronicle of Higher Education, 2017
  - Fellow, Geochemical Society and European Association of Geochemistry, 2015
  - Howard Hughes Medical Institute Professor, 2014
  - Fellow, Geological Society of America, 2003
  - Donath Medal (Young Scientist Award), Geological Society of America, 2002

Post-Ph.D. Research Supervisees (cumulative, alphabetical)

Dr. Gail Arnold, Ph.D. 2004, U. Rochester; ASU Research Scientist, '05 – '07
Present Position: Asst. Dean and Director, Medical Professions Institute, U. Texas – El Paso

Dr. Jane Barling, Ph.D. 1990, Monash University; UR Research Scientist, '98 – '02
Present Position: Senior Research Fellow, University of Oxford

Dr. Melanie Channon, Ph.D. 2012, Caltech; ASU Bisgrove Postdoctoral Fellow, '12 – '15
Present Position: Independent Artist

Dr. Geoff Gilleaudeau, Ph.D. 2014, U. Tennessee; NRC Postdoct. Fellow (ASU), '16 – '18
Present Position: Associate Professor, George Mason University

Dr. Gwyneth Gordon, Ph.D. 2002, Yale University; ASU Research Scientist ’03 – ’18
Present Position: Assistant Research Prof. and Director, METAL, Arizona State University
Dr. Amy Kelly, Ph.D. 2009, MIT; ASU Postdoctoral Fellow, ’11 – ’12
Present Position: Senior Corporate Relations Advisor, Shell Oil Company
Dr. Brian Kendall, Ph.D. 2008, U. Alberta; Agouron Postdoctoral Fellow (ASU), ’08 – ’12
Present Position: Professor, University of Waterloo
Dr. Brian Majestic, Ph.D. 2007, U. Wisc.; Dreyfus Env. Sci. Fellow (ASU), ’07 – ’09
Present Position: Associate Professor, University of Denver
Dr. Amisha Poret-Peterson, Ph.D. 2009, U. Louisville; ASU Research Scientist, ’12 – ’15
Present Position: Research Microbiologist, USDA-ARS
Dr. Kathryn Rico, Ph.D., 2020, U. Michigan; ASU Postdoctoral Fellow, ’22 – present
Present Position: ASU Postdoctoral Fellow
Dr. Steven Romaniello, Ph.D. 2012, ASU; ASU Research Scientist, ’14 – ‘19
Present Position: Director of Geochemistry, Vesta
Dr. Moutusi Roy, Ph.D. 2011, Oregon State U.; ASU Research Scientist, ’12 – ’15
Present Position: Research Staff, Boston Analytical
Dr. Christopher Siebert, Ph.D. 2002, U. Bern; ASU Postdoctoral Fellow, ’05 – ’06
Present Position: Research Scientist, GEOMAR
Dr. Laura Wasylenki, Ph.D. 1998, Caltech; ASU Research Scientist, ’04 – ’10
Present Position: Retired Professor, Northern Arizona University
Dr. Felisa Wolfe-Simon, Ph.D. 2006, Rutgers; ASU Postdoctoral Fellow, ’06 – ’07
Present Position: Senior Research Scientist, Bay Area Environmental Research Institute
Dr. Gregory Wortman, Ph.D. 1998, Syracuse University; UR Research Associate, ’99 – ’01
Present Position: Senior Scientist, Honeywell UOP
Dr. Wang Zheng, Ph.D. 2010, Trent University; ASU Research Specialist, ’15 – ’18
Present Position: Assistant Professor, Tianjin University

ETX Center Staff Supervisees (cumulative since 2015; *indicates current staff)

Mr. Christopher Andert, User Experience Designer*
Ms. Ana Aranda, Community Coordinator*
Mr. David Armijo, Multimedia Designer
Ms. Mia (Bodin) Brunkhorst, Learning Designer and Technical Lead*
Mr. Don Bratton, Manager of Learning Design
Mr. Geoffrey Bruce, Exploration Architect*
Ms. Tess Calvert, Technical Lead
Ms. Katrina Fogelson, Associate Learning Designer
Ms. Chelsea Goldsmith, Project Manager
Mr. Brandon Hasty, Learning Designer*
Ms. Hannah Hauan, Learning Designer
Mr. Richard Hines, Learning Designer
Dr. Lev Horodyskyj, Learning Design Architect
Ms. Diana Hunsley, Manager of University Projects*
Ms. Sina Kirk, Community Coordinator*
Mr. Theo Landry, Project Manager
Ms. Kim Larson, Product Owner*
Ms. Alice Letcher, Project Manager
Mr. Leon Manfredi, Learning Designer

Ms. Elizabeth McHugh, Administrative Director and Chief Culture Officer
Dr. Christopher Mead, Research Manager*
Ms. Melanie Narish, Learning Designer*
Mr. Michael Potter, Developer
Ms. Melissa Renfrey, Project Manager
Ms. Siobhan Sackey, Learning Designer
Mr. Kevin Segovia, Technical Support*
Mr. Jeffrey Schatzki, Business Operations*
Mr. Josef Shindler, Game Design Lead
Ms. Jessica Swann, Community Manager*
Mr. Joseph Tamer, Program Manager & Asst. Director*
Ms. Wendy Taylor, Curriculum Developer
Ms. Veanessya Vazquez Lopez, Learning Designer
Ms. Bianca Zietal, Associate Instructional Designer

Awards & Honors

Individual – National and International

AGU College of Fellows Distinguished Lecturer, Biogeosciences, 2023
Carl Sagan Lecture, American Geophysical Union, 2022
Fellow, American Geophysical Union, 2021
Arthur L. Day Medal, Geological Society of America, 2020
Science Innovation Award (Epstein Medal), European Association of Geochemistry, 2019
Distinguished Miller Lecturer in Geography, Pennsylvania State University, 2018
Named one of 10 "teaching innovators", Chronicle of Higher Education, 2017
Endowed Biogeochemistry Lecture at Goldschmidt Conference, Geochemical Society, 2017
Fellow, Geochemical Society and European Association of Geochemistry, elected 2015
Howard Hughes Medical Institute Professor, 2014
Award for Excellence (education/academic), Academy of Interactive & Visual Arts, 2013
Visiting Professor, Hebrew University, Jerusalem, Israel, Spring 2012
Fellow, Geological Society of America, elected 2003
Young Scientist Award (Donath Medal), Geological Society of America, 2002
National Merit Scholarship, 1985

Individual – Local

ASU "Professor of Impact" Awards (3 student selections), 2023
ASU Alumni Association Founders Day Teaching Achievement Award, 2018
Gary Krahenbuhl Difference Maker Award, Arizona State University, 2015
President's Professor, Arizona State University, 2013
Selected "Most Influential Professor" by a graduating athlete, Arizona State University, 2013
Last Lecture Series Award, Arizona State University, 2006
Cindy Arveson Memorial Award, California Institute of Technology, 1993
NSF Graduate Research Fellowship, California Institute of Technology, 1989 – 1992
Homestake Mining and Economic Geology Award, Harvard University, 1988
Harvard College Scholarship, 1986 - 1989

As Mentor or Team Member

Outstanding Undergraduate – College of Liberal Arts and Sciences, Aaron Flores, Spring 2022
NASA FINESST Fellowship, Dan Sullivan (ASU), 2020 – 2023

Outstanding Paper Award (Mead et al., 2019), Journal of Geoscience Education, 2020
ASU First Year Fellowship, Pilar Vergeli (ASU), 2018 - 2019
NSF Graduate Research Fellowship, Logan Tegler (ASU/MIT-WHOI), 2018 - 2021
NESSF Fellowship, Aleisha Johnson (ASU), 2017 - 2020
NSF Graduate Research Fellowship, Chad Ostrander (ASU), 2016 - 2019
Outstanding Student Poster Award, AGU, Marc Neveu (ASU), 2013
NSF Graduate Research Fellowship, Bryan Rolfe (ASU/Cornell), 2011
Nininger Meteorite Award, Greg Brennecka (ASU), 2010
GSA Outstanding Student Research Award, Greg Brennecka (ASU), 2010
P.E.O. International Scholar Award, Jennifer Glass (ASU), 2010
Student Poster 1st Prize, SoCA Geobiology Symposium, Jennifer Glass (ASU), 2010
Student Poster 2nd Prize, AbSciCon, Jennifer Glass (ASU), 2010
Brian Mason Award of the Meteoritical Society, Greg Brennecka (ASU), 2009
Goldwater Scholarship, Bryan Rolfe (ASU), 2008
Outstanding Student Talk, SoCal Geobiology Symp. Jennifer Glass (ASU), 2007
NSF Graduate Research Fellowship, Jennifer Glass (ASU), 2007 - 2010
Student Poster 1st Prize, AbSciCon, Gail Arnold (UR), 2004
Outstanding Student Poster Award, AGU, Matt Polizotto (UR), 2000
Goldwater Scholarship, Matt Polizzotto (UR), 2000

Major Professional Service

NASA and Related

NASA Interdisciplinary Consortia for Astrobiology Research (ICAR) Review Panel, Member, 2025
NASA Astrobiology and the Future of Life Meeting, Science Organizing Committee, 2024
LIFE Research Coordination Network Steering Committee (NASA), Co-Lead, 2022 – present
NASA Science Activation Program Digital Learning Committee, Lead, 2023 – present
NASA Astrobiology Mission Ideation Workshop, Mentor, 2023
Planetary Science Subcommittee of the NASA Advisory Council, Member, 2014 – 2017
2017 Astrobiology Science Conference, Science Organizing Committee, Member, 2016 – 2017
Upstairs-Downstairs Workshop Without Walls, NAI-NExSS-NSF, Lead Organizer, 2016
SETI Institute Scientific Advisory Board, Member, 2014 – 2016
NASA ASTEP Program Review Panel, Member, 2016
Exobiology Program Review Panel, Chief, 2014
Astrobiology Roadmap Workshop, 2014
Life Investigations for Enceladus (LIFE) mission concept, Deputy PI, 2012 – 2015
Science Team, Enceladus Life Finder (ELF), Member, 2014 – 2020
NASA Astrobiology Institute Executive Council, Member, 2009 – 2014
Supporting Research & Technology SAG, MEPAG, Member, 2010
Mars Mid-Rover SAG, MEPAG, Member, 2009
Science & Technology Committee of the Human Space Flight Review Team, Member, 2009
Science Steering Committee, Astrobiology Science Conference, Chair, 2007 – 2008
Joint Science Definition Team, Europa Jupiter System Mission, Member, 2008 – 2010
Science Organizing Committee, Pale Blue Dot III, Member, 2006
Science Organizing Committee, AbSciCon, Member, 2006
Science Organizing Committee, NAC Lunar Exploration Science Workshop, Member, 2006
Planetary Science Subcommittee of the NASA Advisory Council, Member, 2006 – 2008
Invited Oral Testimony to President's Commission on Moon, Mars and Beyond, 2004

Mars-Moon Science Steering Group, NASA, Member, 2004
Lunar Exploration Analysis Group (LEAG), NASA, Member, 2005 - present
Mission to Early Earth Focus Group, NASA Astrobiology Institute, Co-Chair, 2001 – 2007
Deep Time Drilling Project, Co-Chair, 2002 – 2008
Steering Committee, Astrobiology Drilling Program, Member, 2003 – 2013
NASA Early Career Workshop, Panelist, LPSC Meeting, '04

Other Extramural

Canada Institute for Advanced Research CIFAR), Earth 4D Program Review panelist, 2025
Treatise on Geochemistry 3rd Edition (Elsevier), Co-Editor-in-Chief, 2021 – 2025
Geochemical Society, Nominations Committee, Member, 2023 – present
AGU College of Fellows Distinguished Lecture Series Subcommittee, Chair, 2024 – present
AGU College of Fellows Executive Committee, Member, 2024 – present
University of California Riverside Graduate Program Review Committee, 2024
AGU College of Fellows Distinguished Lecture Series Subcommittee, Member, 2023
Cooperative Institute for Dynamic Earth Research (CIDER), Co-Organizer, 2019 – 2022
Ad-hoc Earth-Life Science Awards Committee, American Geophysical Union, Lead, 2019 – 2021
HHMI Society of Professors Executive Board, Member, 2018 – 2021
NSF Future Substance of STEM Education Workshop, Chair of Steering Committee, 2019 – 2020
Biogeosciences Section of the American Geophysical Union, Past-President, 2019 – 2020
Biogeosciences Section of the American Geophysical Union, President, 2017 – 2019
Biogeosciences Section of the American Geophysical Union, President-Elect, 2015 – 2017
Search Committee for GeoHealth journal, American Geophysical Union, Chair, 2016 – 2017
Planetary Intelligence: Managing Earth's Future, AGU Meeting Union Panel, Co-Organizer, 2016
Invited Oral Testimony to NAS panel on STEM undergraduate research experiences, 2016
Chemical Geology Special Issue dedicated to H.D. Holland, Co-Editor, 2012 – 2013
Frontiers in Microbiological Chemistry, Specialty Chief Co-Editor, 2010 – 2017
Advisory Board, *Metallomics* (RSC), Member, 2010 – 2019
Editorial Board, *Geochemical Perspectives Letters* (EAG), Member, 2017 – 2020
Editorial Board, *Chemical Geology* (Elsevier), Member, 2006 – 2016
Editorial Board, *Metallomics* (RSC), Member, 2008 – 2010
Editorial Board, *Geology* (GSA), Member, 2003 – 2005; 2006 – 2008
Editorial Advisory Board, *Geobiology* (Blackwell Publishing), Member, 2003 – 2008
Int'l Society for the Study of the Origin of Life; ISSOL, Elected Councillor, 2008 - 2011
Gordon Conference on Environmental Bioinorganic Chemistry, Co-Chair, 2008 – 2010
International Program Committee, Goldschmidt '05, '06, Member
Co-Convener: ~ 30 special sessions at AGU, GSA and Goldschmidt meetings
Invited Participant to various workshops including: Life Detection (NAS, 2000); Geobiology (Amer. Acad. Microbio., 2000); Paleoproxies (NSF, 2005); Biosignatures (NRC, 2006); Oxygen (Agouron, 2006); Deep Drilling (Agouron, 2006); Nitrogen (Agouron, 2009); Geobiology (NSF, 2010); Astrobiology Roadmap (2014)
Reviewer of publications for GCA, EPSL, Chem. Geol., Anal. Chem., Science, Nature
Reviewer of proposals for NSF and NASA
Lead and supporting nominator of candidates for various awards by the American Geophysical Union, Geological Society of America, and American Chemical Society; emphasis on inclusive nominations

ASU – SESE/GLG

Center for Education Through Exploration, Director, 2015 – present

Teaching Evaluation Committee, Member, 2022 – present
Faculty Search Committee, Planetary Sciences, Chair, 2023 – 2024
Awards Committee, Member, 2021 – 2022
Teaching and Learning Committee, Chair, 2022 – 2023
SESE Colloquium Committee, Chair, 2019 – 2022
Ad Hoc Future Facilities and Space Planning Committee, Chair, 2019 – 2022
Faculty Search Committee – Science Education, Member, 2019 – 2020
Promotion and Tenure Committee, Member, 2008 – 2009 (sabbatical substitute); 2012 – 2014
Ad Hoc Bateman Space Allocation Committee, Chair, 2011 – 2013
Faculty Search Committee – Isotope Geochemistry, Member, 2012 - 2013
Heptennial Review Committee, Member, 2010 – 2011
Graduate Committee, Member, 2005 – 2008 (Chair of Oversight Subcommittee, 2007-2008)
Faculty Search Advisory Committee, Member, 2006
GLG/SESE Honors Disciplinary Advisor, 2005 – present
Search Committee for SESE Director, Member, 2005 – 2006
Faculty Safety Officer, 2004 – 2005
Structure/Governance Subcommittee (during SESE conceptualization process), Member, 2004
Active participant of various *ad hoc* committees for faculty searches and curriculum redesign

ASU – School of Molecular Sciences
Personnel and Budget Committee, Member, 2023 – present
Graduate Program Committee, Member, 2020 – 2023
Awards Committee, Member, 2019 – 2023
Faculty Search Committee – Materials of the Universe initiative, Member, 2021 – 2022
Undergraduate Program Committee, Member, 2016 – 2017
Committee on Interdepartmental Relations, Member, 2014 – 2015
Committee on School Formation, Member, 2014 – 2015
Committee on Online Course Materials and Development, Member, 2014 – 2015
Personnel and Budget Committee, Member, 2008 – 2009; 2012 – 2015
Strategic Planning – Chemistry of Global Sustainability – Committee, Member, 2008
Strategic Planning Committee, Member, 2007
Awards Committee, Member, 2007 – 2008
Faculty Search Committee for Bioinorganic Faculty, Member, 2005
Septenniel Review Committee, Member, 2005
Seminar Committee, Member, 2004 – 2005

ASU – Other
President's Academic Council, Member, 2014 – present
ASU Jewish Faculty & Staff Association, Steering Committee, Chair, 2024 – present
ASU-ADL Antisemitism Summit, Panelist, 2025
College Digital Initiatives Committee, Member, 2024 – 2025
ASU Jewish Faculty & Staff Association, *ad hoc* planning committee, 2023 – 2024
Provost's Committee on Generative AI, 2023 – 2024
KED Chemical and Environmental Core Facility Board, Member, 2017 – 2020
ASU Team Leadership Academy (PlanetWorks Team), Co-Lead, 2016 – 2018
ASU PlanetWorks Initiative, Co-Lead, 2015 – 2018
Planetary Design: Climate 3.0 Workshop, Co-Lead Organizer, 2016
Advisory Board, Institute for the Science of Teaching and Learning, Member, 2014 – 2015

Provost's Working Group on General Education, Chair, 2013 – 2014
Funding Success Skills Series, OKED ASU, Panelist, 2014
General Studies Council, Member, 2013 – 2016
Arizona Science Education Consortium Executive Committee, Member, 2012 – 2015
ReSETS Committee, CLAS and Mary Lou Fulton Teacher's College, Member, 2011 – 2012
Provost's Committee on Excellence in Digital Learning and Teaching, Member, 2011 - 2013
Biodesign Graduate Program Committee, Member, 2012 – present
ASU Astrobiology Program, Director, 2009 – 2015
Origins Project Faculty Advisory Committee, Member, 2009 – 2012
Origins Symposium Program Committee, Member, 2008 – 2009
Provisional Steering Committee, Environmental Life Science Graduate Program, Member, 2008
Curriculum Development, School of Sustainability (no formal committee), Member, 2006 – 2008
Keck Laboratory Executive Committee, Member, 2004 – 2019
ASU Provost's Teaching Awards Committee, Member, 2007
Biogeochemistry Interest Group, Organizer (w/Hilairy Hartnett), 2005 – 2006

U. Rochester
V.P. Campus Affairs, Hillel of Rochester Area Colleges, 2001 – 2002
Faculty Advisor, Sigma Epsilon Fraternity, 2001 – 2004
Freshman Housing Implementation Committee, 2000 – 2002
Residential College Commission, Member, 1997 – 1999
Faculty-in-Residence, 1996 – 1999
Panelist for NSF and NASA funding programs

Significant Public Outreach & Media Coverage

RETRACTED – Arsenic Life Controversy. Periodic Table Videos, January, 2026.
https://youtu.be/g4BH4rIBqsc?si=Qpxcx20b-bBhisgw

Controversial 'arsenic life' paper retracted after 15 years – but authors fight back. Nature, July, 2025.
https://www.nature.com/articles/d41586-025-02325-z

Claim of Microbe That Survives on Arsenic Is Retracted After 15 Years. NY Times, July, 2025.
https://www.nytimes.com/2025/07/24/science/arseniclife-retraction-science.html

After ASU's antisemitism warning from the feds, Jewish campus leaders defend university. Arizona Republic, March 2025.
https://www.azcentral.com/story/news/local/arizona-education/2025/03/13/asu-jewish-groups-rebuke-federal-antisemitism-claims/82342058007/

The complicated history of how Earth's atmosphere became breathable. Ars Technica, May 2023.
https://arstechnica.com/science/2023/05/the-complicated-history-of-how-the-earths-atmosphere-became-breathable/3/

To better understand Arizona's water supply, we retrace its origins. KJZZ (PBS), July 2022.
https://kjzz.org/content/1792236/better-understand-arizonas-water-supply-we-retrace-its-origins

Democratization of Higher Ed Content Creation: ASU and CMU. ASU GSV Summit, August 2021
https://www.asugsvsummit.com/video/democratization-of-higher-ed-content-creation-asu-and-cmu

Are We Alone? Reason, religion, and the search for life in the universe. Valley Beit Midrash lecture, December 2020
https://youtu.be/GvW8Pyq7VHI

Habitable Planets Beyond Earth with Ariel Anbar. ASU *Learn with Me* playlist, September 2020
https://youtube.com/playlist?list=PLNrrxHpJhC8k5ef8bmc0mpOt7wJg4i9Fs

ASU pilot class creates immersive 'virtual field trips' as teaching tool, January 2019
https://www.azfamily.com/news/asu-pilot-class-creates-immersive-virtual-field-trips-as-teaching/article_15ba817c-211c-11e9-b8f2-ebf3a5975058.html

Curiosity Rover discovers organic molecules on Mars. Fox10, June 8, 2018
https://youtu.be/pFWob_GFmH4?si=f5Eko7hHVhgg8PoN

Stable Isotopes Offer Novel Methods of Disease Detection. Earth Magazine, January 2018
https://www.earthmagazine.org/article/stable-isotopes-offer-novel-methods-disease-detection

Chronicle of Higher Education special report on "10 Classroom Trailblazers", October 2017
http://www.chronicle.com/specialreport/Innovators-10-Classroom/156

Designing Earth's Future – ASU KEDtalk, September 2017
https://research.asu.edu/stories/asu-kedtalk-designing-earths-future

Inside Higher Ed report on the Infiniscope project, "Reaching for the Stars", April 2017
https://www.insidehighered.com/digital-learning/article/2017/04/12/asu-uses-nasa-data-create-middle-and-high-school-program

Scientists Discover the Heavens are Hell. BloombergView, March 2017
https://www.bloomberg.com/view/articles/2017-03-06/scientists-discover-the-heavens-are-hell

Educating Through Exploration. TEDxASU presentation, March 2017
https://www.youtube.com/watch?v=g5Ait70JOqI

HabWorlds featured in *A National Education Call to Action.* Inside Higher Ed, January 2017
https://www.insidehighered.com/blogs/higher-ed-gamma/national-educational-technology-call-action

HabWorlds highlighted in Reimagining the Role of Technology in Higher Education, Office of Educational Technology, U.S. Dept. of Education, January 2017
https://tech.ed.gov/files/2017/01/Higher-Ed-NETP.pdf

KJZZ (PBS) Interview with Mark Brodie: Getting scientists on the same page, December 2016
http://theshow.kjzz.org/content/405009/trying-get-scientists-different-disciplines-same-page

Digital Learning's Pioneers are Cautiously Optimistic. EdSurge, July 2016
https://www.edsurge.com/news/2016-07-10-digital-learning-s-pioneers-are-cautiously-optimistic
The Great Oxidation Event - Evolving understandings of how oxygenic life on Earth began. BioScience, February, 2016
http://bioscience.oxfordjournals.org/lookup/doi/10.1093/biosci/biv193
'Academic crowdsourcing' allows lecturers to share ideas. Times Higher Education, 2016
https://www.timeshighereducation.com/news/academic-crowdsourcing-allows-lecturers-share-ideas
Is Pluto a Planet? Who Cares! Op-ed in Slate, 2015
http://www.slate.com/articles/technology/future_tense/2015/07/new_horizons_what_pluto_tells_us_about_scientific_literacy.html
e-Literate TV feature about *Habitable Worlds*, 2015
https://e-literate-tv.inthetelling.com/#/episode/553fe28241f6dfb4e4003566/
Phoenix Magazine – Movers & Shakers, 2015
http://www.phoenixmag.com/people/2015-movers-shakers-ariel-anbar.html
Chronicle of Higher Education feature on STEM education, 2015
http://chronicle.com/article/Teaching-Science-So-It-Sticks/229881/?key=HGt3JwVkZHlOZSxkZTdFNDcBb3JsYkwmZiAYOH11blFXGA==
Forbes coverage of Enceladus mission concepts, 2015
http://www.forbes.com/sites/brucedorminey/2015/04/29/nasa-may-plumb-for-signs-of-life-in-enceladus-plume/
Scientific American coverage of Habitable Worlds, 2015
http://blogs.scientificamerican.com/observations/2015/01/21/habitable-worlds-course/
Campus Technology coverage of Inspark Science Network, 2015
http://campustechnology.com/articles/2015/01/20/college-network-transforming-science-gains-momentum.aspx
Inside Higher Ed coverage of Habitable Worlds, 2014
https://www.insidehighered.com/news/2014/10/10/emerging-adaptive-software-puts-faculty-members-charge-course-creation
Higher Ed Live webcast: Thought Leaders in Ed Tech: The Inspark Science Network, 2014
http://www.higheredlive.com/thought-leaders-in-ed-tech-the-inspark-science-network/
NSF Discoveries feature on HHMI-supported immersive virtual field trips, 2014
http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=132758
Organizer and panelist for ASU National and Global Issues Forum: Space Exploration: How and Why? November, 2013, National Press Club
http://forum.asu.edu/forum/space-exploration
http://sese.asu.edu/news/success-new-space-era-hinges-publics-interest
Emerge 2013 Workshop Lead: Is the Truth Out There? Hunting for Habitable Worlds.
http://emerge2013.asu.edu/workshops/is-the-truth-out-there-hunting-for-habitable-worlds/
eLiterate feature story, 2013
http://mfeldstein.com/the-openclass-vision-an-example/
Forbes coverage of Dynamics of Earth System Oxygenation project, 2013
http://www.forbes.com/sites/brucedorminey/2013/08/31/oxygens-ancient-rise-still-one-of-earths-biggest-mysteries/
TED Ed Video, A Needle in Countless Haystacks: Finding Habitable Worlds, 2012
http://ed.ted.com/lessons/a-needle-in-countless-haystacks-finding-habitable-planets-ariel-anbar
American Institute of Physics video production on Ca isotopes and bone, 2012
Filmed in 2012; in production
Channel 8 (PBS), ASU Discovers: Science of Detection, 2012
http://www.youtube.com/watch?v=V6cLr40_4Rw
Chemical Heritage Foundation Podcast: Bones, 2012
http://www.chemheritage.org/discover/media/distillations/164-bones.aspx
SIFT Podcast: Define Life, 2012
http://siftpodcast.com/define-life/
Channel 12 (NBC), *12 News*: 2012: End of the World? (w/Michael Smith), 2011

http://www.azcentral.com/video/#/2012%3A+End+of+the+world%3F/1339820820001

Channel 8 (PBS), *Horizons*: Ocean Chemistry Research (w/Greg Brennecka), 2011
https://youtu.be/mnIdUys-BHs?si=xFzOpq3x9Am9bOa6

Scottsdale Museum of Contemporary Art: science presentation for "90 Days over 100°", 2010
http://phxated.com/scott-andrews/90-days-over-100-at-smoca-closing-event/

KJZZ (PBS), *Interview with Dennis Lambert*: Uncovering Earth's Oxygenation, 2010
http://archive.kjzz.org/news/arizona/archives/201010/ME_OceanOxygen

Channel 8 (PBS), *Horizons*: New Life on Earth (w/Paul Davies), 2010
https://youtu.be/1OlknShGbDQ?si=cpCDzdtD0oYWsffp

Channel 8 (PBS), *Minds over Matters*: pilot (w/Phil Christensen), 2009
http://www.azpbs.org/video/play.php?vidId=1521

Science Friday: Astrobiology & the Origin of Life (with panel), 2009
http://www.sciencefriday.com/program/archives/200904032

Publications and Presentations

* = Anbar-mentored student first author
# = Anbar-mentored postdoc or staff first author
¶ = Anbar-mentored visiting student or scientist first author

Total Refereed Publications in Print or Press (self-counted): 215
Total Citations (Google Scholar): 29,679 (11,311 since 2021)
h-index (Google Scholar): 90 (62 since 2021)
i10-index (Google Scholar): 205 (180 since 2021)

Refereed Publications in Print or Press:

1. T. J. Algeo, M. N. Remirez, H. Zhao, L. Schwark, G. Gordon, A. D. Anbar, S. Bates, T. Lyons, D. J. Over, and B. Sageman (2025). Transient glacio-eustatic fall and its climato-environmental effects during the Frasnian-Famennian transition. *Global and Planetary Chan*ge **256**: 105135 (https://doi.org/10.1016/j.gloplacha.2025.105135)

2. *X. Chen, C. M. Ostrander, B. J, Holdaway, B. Kendall, A. D. Anbar, and S. G. Nielsen (2025). Transient marine bottom water oxygenation on continental shelves by 2.65 billion years ago. *Nature Geoscience* **18**: 423-429. (https://doi.org/10.1038/s41561-025-01681-9)

3. #G. J. Gilleaudeau, X. Chen, S. J. Romaniello, S. A. Akam, C. Wittkop, S. Katsev, A. D. Anbar, and E. D. Swanner (2025). Uranium isotope systematics of a low-productivity ferruginous ocean analog: Implications for the uranium isotope record of early Earth. *Geochimica et Cosmochimica Acta* **392**: 195-206 (https://doi.org/10.1016/j.gca.2025.01.011)

4. #G. J. Gilleaudeau, L. C. Kah, C. K. Junium, and A. D. Anbar (2025). Aerobic nitrogen cycling in a molybdenum-limited, redox-stratified Mesoproterozoic epeiric sea. *Earth and Planetary Science Letters* **661**: 119369 (https://doi.org/10.1016/j.epsl.2025.119369)

5. S. Semken, C. Mead, K. Foley, T. Ruberto, G. Bruce, and A. D. Anbar (2025). Research on teaching geoscience with Virtual Field Experiences. *Annual Review of Earth and Planetary Sciences* **53**: 425-442. (https://doi.org/10.1146/annurev-earth-060923-115406)

6. #J. Swann, M-K. Severino, K. Perrett, T. Kline, C. Mead, and A. Anbar (2025). Enhancing eclipse education: a universal design approach to comprehensive, ready-to-use curricula for diverse classrooms. *Bulletin of the American Astronomical Society* **56**. (https://doi.org/10.3847/25c2cfeb.cbe8687f)

7. *P. Vergeli, S. J. Romaniello, H. E. Hartnett, and A. D. Anbar (2025). Reassessing the photochemical contribution to Archean Banded Iron Formations. *Chemical Geology*, 122763 (https://doi.org/10.1016/j.chemgeo.2025.122763)

8. G. N. Evans, S. Ji, B. Kaçar, A. D. Anbar, and W. E. Seyfried Jr. (2024). Transition metals in alkaline Lost City vent fluids are sufficient for early-life metabolisms. *Geochimica et Cosmochimica Acta* **385**: 61-73 (https://doi.org/10.1016/j.gca.2024.08.020)

9. *D. L. Sullivan, G. A. Brennecka, K. E. Grant, and A.D. Anbar (2024). Rhenium Isotope Reconnaissance of Uranium Ore Concentrates. *Earth and Planetary Science Letters* **644**: 118898 (https://doi.org/10.1016/j.epsl.2024.118898)

10. J. Hodgkins, A. Bertacchi, K. J. Knudson, T. Rasbury, J. I. Giblin, G. Gordon, A. Anbar, A. Turq, D. Sandgathe, H. M. Keller, K. Britton, S. P. McPherron (2024). Late Pleistocene prey mobility in southwestern France and its implications for reconstructing Neandertal ranging behaviors. *Quaternary Science Reviews*, 331: 108610. (https://doi.org/10.1016/j.quascirev.2024.108610)

11. A. D. Anbar, R. Buick, G.W. Gordon, A. C. Johnson, B. Kendall, T. W. Lyons, C. M. Ostrander, N. J. Planavsky, C. T. Reinhard, and E. E. Stüeken, E. E. (2023). Technical comment on "Reexamination of 2.5-Ga 'whiff' of oxygen interval points to anoxic ocean before GOE." *Science Advances*, **9**: eabq3736. (https://doi.org/10.1126/sciadv.abq3736)

12. #G. J. Gilleaudeau, W. Wei, M. N. Remírez, Y. Song, T. W. Lyons, S. Bates, A. D. Anbar, and T. J. Algeo, (2023). Geochemical and hydrographic evolution of the Late Devonian Appalachian Seaway: Linking sedimentation, redox, and salinity across time and space. *Geochemistry, Geophysics, Geosystems*, **24**: p.e2023GC010973. (https://doi.org/10.1029/2023GC010973)

13. #*C. Mead, C. Price, L. E. Gin, A. D. Anbar, J. P. Collins, P. LePore, and S. E. Brownell (2023). A comparative case study of the accommodation of students with disabilities in online and in-person degree programs. *PLOS One*, **18**: p.e0288748. (https://doi.org/10.1371/journal.pone.0288748)

14. T. Ruberto, C. Mead, A. D. Anbar, and S. Semken, (2023). Comparison of in-person and virtual Grand Canyon undergraduate field trip learning outcomes. *Journal of Geoscience Education*, **71**: 445-461. (https://doi.org/10.1080/10899995.2023.2186067)

15. ¶H. Song, T. J. Algeo, H. Song, J. Tong, P. B. Wignall, D. P. G. Bond, W. Zheng, X. Chen, S. J. Romaniello, H. Wei, H., and A. D. Anbar (2023). Global oceanic anoxia linked with the Capitanian (Middle Permian) marine mass extinction. *Earth and Planetary Science Letters*, **610**: 118128. (https://doi.org/10.1016/j.epsl.2023.118128)

16. R. Sun, Y. Liu, J. E. Sonke, F. Zhang, Y. Zhao, Y. Zhang, J. Chen, C.-Q. Liu, S. Shen, S., A. D. Anbar, and W. Zheng (2023). Mercury isotope evidence for marine photic zone euxinia across the end-Permian mass extinction. *Communications Earth & Environment*, **4**: 159. (https://doi.org/10.1038/s43247-023-00821-6)

17. *L. A. Tegler, A. M. Sherry, P. Herckes, S. J. Romaniello, and A. D. Anbar (2023). Up in smoke: Most aerosolized Fe from biomass burning does not derive from foliage. *Global Biogeochemical Cycles*, **37**: p.e2023GB007796. (https://doi.org/10.1029/2023GB007796)

18. [#]W. Zheng, C. J. Gilleaudeau, T. J. Algeo, Y. Zhao, Y. Song, Y. Zhang, S. K. Sahoo, A. D. Anbar, S. K. Carmichael, S. Xie, C.-Q. Liu, and J. Chen (2023). Mercury isotope evidence for recurrent photic-zone euxinia triggered by enhanced terrestrial nutrient inputs during the Late Devonian mass extinction. *Earth and Planetary Science Letters*, **613**: 118175. (https://doi.org/10.1016/j.epsl.2023.118175)

19. [#]W. Zheng, A. Zhou, S. K. Sahoo, M. R. Nolan, C. M. Ostrander, R. Sun, A. D. Anbar, S. Xiao, and J. Chen, (2023). Recurrent photic zone euxinia limited ocean oxygenation and animal evolution during the Ediacaran. *Nature Communications*, **14**: 3920. (https://doi.org/10.1038/s41467-023-39427-z)

20. S. Bruggmann, G. J. Gilleaudeau, S. J. Romaniello, S. Severmann, D. E. Canfield, A. D. Anbar, Florian Scholz, and R. Frei (2022). Uranium isotope cycling on the highly productive Peruvian margin. *Chemical Geology* **590**: 120705. (https://doi.org/10.1016/j.chemgeo.2021.120705)

21. [¶]J. Chen, I. P. Montañez, S. Zhang, T. T. Isson, S. I. Macarewich, N. J. Planavsky, F. Zhang, S.Rauzi, K. Daviau, L. Yao, Y-P. Qi, Y. Wang, J-X. Fan, C. J. Poulsen, A. D. Anbar, S-Z. Shen, and X-D. Wang (2022). Marine anoxia linked to abrupt global warming during Earth's penultimate icehouse. *Proceedings of the National Academy of Science* **119**: e2115231119. (https://doi.org/10.1073/pnas.2115231119)

22. [*]X. Chen, S. A. Robinson, S. J. Romaniello, and A. D. Anbar (2022). $^{238}U/^{235}U$ in calcite is more susceptible to carbonate diagenesis. *Geochimica et Cosmochimica Acta* **326**: 273-287. (https://doi.org/10.1016/j.gca.2022.03.027)

23. S. Desch, A. P. Jackon, J. L. Noviello, and A. D. Anbar (2022). The breakup of a long-period comet is not a likely match to the Chicxulub impactor. *Scientific Reports* **12**: 10415. (https://doi.org/10.1038/s41598-021-82320-2)

24. [#*]C. Mead, G. Bruce, W. Taylor, S. Buxner, S., and A.D. Anbar (2022). Gamifying virtual exploration of the past 350 million years of vertebrate evolution. *Frontiers in Education*, **7**: 836783. (https://doi.org/10.3389/feduc.2022.836783)

25. [*]C. M. Ostrander, B. Kendall, G. W. Gordon, S. G. Nielsen, W. Zheng, and A. D. Anbar (2022). Shale heavy metal isotope records of low environmental O_2 between two Archean oxidation events. *Frontiers in Earth Science* **10**: 833609. (https://doi.org/10.3389/feart.2022.833609)

26. [*]C. M. Ostrander, S. Severmann, G. W. Gordon, B. Kendall, T. W. Lyons, W. Zheng, M. Roy, and A. D. Anbar (2022). Significance of ^{56}Fe depletions in late-Archean shales and pyrite. *Geochimica et Cosmochimica Acta* **316**: 87-104. (https://doi.org/10.1016/j.gca.2021.10.013)

27. [*]F. Zhang, R. G. Stockey, S. Xiao, S-Z. Shen, T. W. Dahl, G-Y. Wei, M. Cao, Z. Li, J. Kang, Y. Cui, A. D. Anbar, and N. J. Planavsky (2022). Uranium isotope evidence for extensive shallow water anoxia in the early Tonian oceans. *Earth and Planetary Science Letters* **583**: 117437. (https://doi.org/10.1016/j.epsl.2022.117437)

28. M. L. Cable, C. Porco, C. R. Glein, C. R. German, S. M. MacKenzie, M. Neveu, T. M. Hoehler, A. E. Hofmann, A. R. Hendrix, J. Eigenbrode, F. Postberg, L. J. Spilker, A. McEwen, N. Khawaja, J. H. Waite, P. Wurz, J. Helbert, A. Anbar, J-P. de Vera, and J. Núñez (2021). The Science Case for a Return to Enceladus. *The Planetary Science Journal* **2**: 132. (https://doi.org/10.3847/PSJ/abfb7a)

29. *X. Chen, S. Romaniello, and A. D. Anbar (2021). Preliminary exploration of molybdenum isotope fractionation during coprecipitation of molybdate with abiotic and microbial calcite. *Chemical Geology* **566**: 120102. (https://doi.org/10.1016/j.chemgeo.2021.120102)

30. *X. Chen, S. J. Romaniello, M. McCormick, A. Sherry, J. R. Havig, W. Zheng, and A. D. Anbar (2021). Anoxic depositional overprinting of $^{238}U/^{235}U$ in calcite: When do carbonates tell black shale tales? *Geology* (https://doi.org/10.1130/G48949.1)

31. S. Desch, A. Jackson, J. Noviello, and A. Anbar (2021). The Chicxulub impactor: comet or asteroid? *Astronomy & Geophysics* **62**: 3-34. (https://doi.org/10.1093/astrogeo/atab069)

32. A. G. Dunlea, L. A. Tegler, B. Peucker-Ehrenbrink, A. D. Anbar, S. J. Romaniello, and T. J. Horner (2021). Pelagic clays as archives of marine iron isotope chemistry. *Chemical Geology* **575**: 120201. (https://doi.org/10.1016/j.chemgeo.2021.120201)

33. B. C. Gill, T. W. Dahl, E. U. Hammarlund, M. A. LeRoy, G. W. Gordon, D. E. Canfield, A. D. Anbar, and T. W. Lyons (2021). Redox dynamics of later Cambrian oceans. *Palaeogeography, Palaeoclimatology, Palaeoecology* **581**: 110623. (https://doi.org/10.1016/j.palaeo.2021.110623)

34. #G. J. Gilleaudeau, T. J. Algeo, T. W. Lyons, S. Bates, and A. D. Anbar (2021). Novel watermass reconstruction in the Early Mississippian Appalachian Seaway based on integrated proxy records of redox and salinity. *Earth and Planetary Science Letters* 558: 116746. (https://doi.org/10.1016/j.epsl.2021.116746)

35. ¶K. T. Goto, Y. Sekine, T. Ito, K. Suzuki, A. D. Anbar, G. W. Gordon, Y. Harigane, T. Maruoka, G. Shimoda, T. Kashiwabara, and Y. Takaya (2021). Progressive ocean oxygenation at~ 2.2 Ga inferred from geochemistry and molybdenum isotopes of the Nsuta Mn deposit, Ghana. *Chemical Geology* 567: 120116. (https://doi.org/10.1016/j.chemgeo.2021.120116)

36. A. T. Greaney, R. L. Rudnick, S. J. Romaniello, A. C. Johnson, A. D. Anbar, and M. L. Cummings (2021). Assessing molybdenum isotope fractionation during continental weathering as recorded by weathering profiles in saprolites and bauxites. *Chemical Geology* 566: 120103. (https://doi.org/10.1016/j.chemgeo.2021.120103)

37. S. R. Hlohowskyj, X. Chen, S. J. Romaniello, T. P. Vorlicek, A. D. Anbar, T. W. Lyons, and A. Chappaz (2021). Quantifying molybdenum isotopic speciation in sulfidic water: implications for the paleoredox proxy. *ACS Earth and Space Chemistry* **5**: 2891-9. (https://doi.org/10.1021/acsearthspacechem.1c00247)

38. *A. C. Johnson, C. M. Ostrander, S. J. Romaniello, C. T. Reinhard, A. T. Greaney, T. W. Lyons, and A. D. Anbar (2021). Reconciling evidence of oxidative weathering and atmospheric

anoxia on Archean Earth. *Science advances 7*: p.eabj0108. (https://doi.org/10.1126/sciadv.abj0108)

39. B. Kaçar, A. K. Garcia, and A. D. Anbar (2021). Evolutionary history of bioessential elements can guide the search for life in the Universe. *ChemBioChem* 22: 114-119. (https://doi.org/10.1002/cbic.202000500)

40. J. Meixnerová, J. D. Blum, M. W. Johnson, E. E. Stüeken, M. A. Kipp, A. D. Anbar, and R. Buick (2021). Mercury abundance and isotopic composition indicate subaerial volcanism prior to the end-Archean "whiff" of oxygen. *Proceedings of the National Academy of Sciences*, 118: e2107511118. (https://doi.org/10.1073/pnas.2107511118)

41. *C. M. Ostrander, A. C. Johnson, and A. D. Anbar (2021). Earth's first redox revolution. *Annual Reviews of Earth and Planetary Sciences* **49**: 337-336. (https://doi.org/10.1146/annurev-earth-072020-055249)

42. ¶H. Song, H. Song, J. Tong, G. W. Gordon, P. B. Wignall, L. Tian, W. Zheng, T. J. Algeo, L. Liang, R. Bai, K. Wu, and A. D. Anbar (2021). Conodont calcium isotopic evidence for multiple shelf acidification events during the early Triassic. *Chemical Geology* 562: 120038. (https://doi.org/10.1016/j.chemgeo.2020.120038)

43. ¶Y. Song, G. J. Gilleaudeau, T. J. Algeo, D. J. Over, T. W. Lyons, A. D. Anbar, and S. Xie (2021). Biomarker evidence of algal-microbial community changes linked to redox and salinity variation, Upper Devonian Chattanooga Shale (Tennessee, USA). *GSA Bulletin* 133: 409-424.

44. K. Supriya, C. Mead, A. D. Anbar, J. L. Caulkins, J. P. Collins, K. M. Cooper, P. C. LePore, T. Lewis, A. Pate, R. A. Scott, and S. E. Brownell (2021). Undergraduate biology students received higher grades during COVID-19 but perceived negative effects on learning. *Frontiers in Education*: 428. (https://doi.org/10.3389/feduc.2021.759624)

45. M. Cao, S. J. Daines, T. M. Lenton, H. Cui, T. J. Algeo, T. W. Dahl, W. Shi, Z. Q. Chen, A. D. Anbar, and Y. Q. Zhou (2020). Comparison of Ediacaran platform and slope $\delta^{238}U$ records in South China: Implications for global-ocean oxygenation and the origin of the Shuram Excursion. *Geochimica et Cosmochimica Acta* **287**: 111-124.

46. *X. Chen, W. Zheng, and A. D. Anbar (2020). Uranium isotope fractionation ($^{238}U/^{235}U$) during U(VI) uptake by freshwater plankton. *Environmental Science and Technology* **54**: 2744-2752.

47. ¶M. Cheng, C. Li, C. Jin, H. Wang, T. J. Algeo, T. W. Lyons, F. Zhang, and A. Anbar (2020). Evidence for high organic carbon export to the early Cambrian seafloor. *Geochimica et Cosmochimica Acta* **287**: 125-140. (https://doi.org/10.1016/j.gca.2020.01.050)

48. #G. J. Gilleaudeau, S. K. Sahoo, C. M. Ostrander, J. D. Owens, S. W. Poulton, T. W. Lyons, and A. D. Anbar (2020). Molybdenum isotope and trace metal signals in an iron-rich Mesoproterozoic ocean: A snapshot from the Vindhyan Basin, India. *Precambrian Research* 105718.

49. D. M. Glaser, H. E. Hartnett, S. J. Desch, C. T. Unterborn, A. Anbar, S. Buessecker, T. Fischer, S. Glaser, S. R. Kane, C. M. Lisse, C. Millsaps, S. Neuer, J. G. O'Roarke, N. Santos, S. I. Walker and M. Zolotov (2020). Detectability of Life Using Oxygen on Pelagic Planets and Water Worlds. *The Astrophysical Journal* **893**: 163.

50. ¶K. T. Goto, Y. Sekine, G. Simoda, J. R. Hein, S. Aoki, A. Ishikawa, K. Suzuki, G. W. Gordon, and A. D. Anbar (2020). A framework for understanding Mo isotope records of Archean and Paleoproterozoic Fe- and Mn-rich sedimentary rocks: Insights from modern marine hydrothermal Fe-Mn oxides. *Geochimica et Cosmochimica Acta* **280**: 221-236.

51. A. T. Greaney, R. L. Rudnick, S. J. Romaniello, A. C. Johnson, R. M. Gaschnig, and A. D. Anbar (2020). Molybdenum isotope fractionation in glacial diamictites tracks the onset of oxidative weathering of the continental crust. *Earth and Planetary Science Letters* **534**: 116083.

52. S. Kadoya, D. C. Catling, R. W. Nicklas, I. S. Puchtel, and A. D. Anbar (2020). Mantle data imply a decline of oxidizable volcanic gases could have triggered the Great Oxidation. *Nature Communications* **11**: 2774. https://doi.org/10.1038/s41467-020-16493-1

53. S. Kadoya, D. C. Catling, R. W. Nicklas, I. S. Puchtel, and A. D. Anbar (2020). Mantle cooling causes more reducing volcanic gases and gradual reduction of the atmosphere. *Geochemical Perspectives Letters* **13**: 25-29. doi: 10.7185/geochemlet.2009

54. A. R. Marcotte, A. D. Anbar, B. J. Majestic and P. Herckes (2020). Mineral Dust and Iron Solubility: Effects of Composition, Particle Size, and Surface Area. *Atmosphere* **11**: 533.

55. #C. Mead, K. Supriya, Y. Zheng, A. D. Anbar, J. P. Collins, P. LePore, and S. E. Brownell (2020). Online biology degree program broadens access for women, first-generation to college, and low-income students, but grade disparities remain. *PLOS One* **15**: e0243916. (https://doi.org/10.1371/journal.pone.0243916)

56. *M. Neveu, A. Anbar, A. F. Davila, D. P. Glavin, S. M. Mackenzie, C. M. Phillips-Lander, B. Sherwood, Y. Takano, P. Williams and H. Yano (2020). Returning Samples from Enceladus for Life Detection. *Frontiers in Astronomy and Space Sciences* **7**: 26.

57. *C. M. Ostrander, B. Kendall, S. L. Olson, T. W. Lyons, G. W. Gordon, S. J. Romaniello, W. Zheng, C. T. Reinhard, M. Roy, and A. D. Anbar (2020). An expanded shale δ^{98}Mo record permits recurrent shallow marine oxygenation during the Neoarchean. *Chemical Geology* **532**: 119391.

58. *C. M. Ostrander, J. D. Owens, S. G. Nielsen, T. W. Lyons, Y. Shu, X. Chen, E. A. Sperling, G. Jiang, D. T. Johnston, S. Sahoo and A. D. Anbar (2020). Thallium isotope ratios in shales from South China and northwestern Canada suggest widespread O_2 accumulation in marine bottom waters was an uncommon occurrence during the Ediacaran Period. *Chemical Geology* **557**: 119856.

59. ¶Y. Song, G. J. Gilleaudeau, T. J. Algeo, D. J. Over, T. W. Lyons, A. D. Anbar and S. Xie (2020). Biomarker evidence of algal-microbial community changes linked to redox and salinity variation, Upper Devonian Chattanooga Shale (Tennessee, USA). *GSA Bulletin* **133**: 409-424.

60. *F. Zhang, T. W. Dahl, T. M. Lenton, G. Luo, S. Z. Shen, T. J. Algeo, N. Planavsky, J. Liu, Y. Cui, W. Qie, S. J. Romaniello, and A. D. Anbar (2020). Extensive marine anoxia associated with the Late Devonian Hangenberg Crisis. *Earth and Planetary Science Letters* **533**: 115976.

61. F. Zhang, T. M. Lenton, A. del Rey, S. J. Romaniello, X. Chen, N. J. Planavsky, M. O. Clarkson, T. W. Dahl, K. V. Lau, W. Wang, Z. Li, M. Zhao, T. Isson, T. J. Algeo, and A. D. Anbar (2020). Uranium isotopes in marine carbonates as a global ocean paleoredox proxy: A critical review. *Geochimica et Cosmochimica Acta* **287**: 27-49. (http://doi.org/10.1016/j.gca.2020.05.011)

62. *F. Zhang, S. Z. Shen, Y. Cui, T. M. Lenton, T. W. Dahl, H. Zhang, Q. F. Zheng, W. Wang, K. Krainer, and A. D. Anbar (2020). Two distinct episodes of marine anoxia during the Permian-Triassic crisis evidenced by uranium isotopes in marine dolostones. *Geochimica et Cosmochimica Acta* **287**: 165-179. (https://doi.org/10.1016/j.gca.2020.01.032)

63. #G. J. Gilleaudeau, S. J. Romaniello, G. Luo. A. J. Kaufman, F. Zhang, R. M. Klaebe, L. C. Kah, K. Azmy, J. K. Bartley, W. Zheng, A. H. Knoll, and A. D. Anbar (2019). Uranium isotope evidence for limited euxinia in mid-Proterozoic oceans. *Earth and Planetary Science Letters* **521**: 150-157.

64. D. A. Ionov, Y-H. Qi, J-T. Kang, A. V. Golovin, O. B. Oleinikov, W. Zheng, A. D. Anbar, Z-F. Zhang, and F. Huang (2019). Calcium isotopic signatures of carbonatite and silicate metasomatism, melt percolation and crustal recycling in the lithospheric mantle. *Geochimica et Cosmochimica Acta* **248**: 1-13.

65. *A. C. Johnson, S. M. Aarons, N. Dauphas, N. X. Nie, H. Zheng, R. T. Helz, S. J. Romaniello, and A. D. Anbar (2019). Titanium isotopic fractionation in Kilauea Iki lava lake driven by oxide crystallization. *Geochimica et Cosmochimica Acta* **264**: 180-190.

66. *A. C. Johnson, S. J. Romaniello, C. T. Reinhard, D. D. Gregory, E. Garcia-Robledo, N. P. Revsbech, D. E. Canfield, T. W. Lyons, and A. D. Anbar (2019). Experimental determination of pyrite and molybdenite oxidation kinetics at nanomolar oxygen concentrations. *Geochimica et Cosmochimica Acta* **249**: 160-172.

67. #C. Mead, S. Buxner, G. Bruce, W. Taylor, S. Semken, and A. D. Anbar (2019). Immersive, interactive virtual field trips promote science learning. *Journal of Geoscience Education* 67: 131-142. (https://doi.org/10.1080/10899995.2019.1565285)

68. R. W. Nicklas, I. S. Puchtel, R. D. Ash, P. M. Piccoli, E. Hanski, E. G. Nisbet, P. Waterton, D. G. Pearson, and A. D. Anbar (2019). Secular mantle oxidation across the Archean-Proterozoic boundary: Evidence from V partitioning in komatiites and picrites. *Geochimica et Cosmochimica Acta* **250**: 49-75.

69. S. L. Olson, C. M. Ostrander, D. D. Gregory, M. Roy, A. D. Anbar, and T. W. Lyons (2019). Volcanically modulated pyrite burial and ocean-atmosphere oxidation. *Earth and Planetary Science Letters* **506:** 417-427.

70. *C. M. Ostrander, S. G. Nielsen, J. D. Owens, B. Kendall, G. W. Gordon, S. J. Romaniello, and A. D. Anbar (2019). Fully oxygenated water columns over continental shelves before the Great Oxidation Event. *Nature Geoscience* **12**: 186-191.

71. *C. M. Ostrander, S. K. Sahoo, B. Kendall, G. Jiang, N. J. Planavsky, T. W. Lyons, S. G. Nielsen, J. D. Owens, G. W. Gordon, S. J. Romaniello, and A. D. Anbar (2019). Multiple negative molybdenum isotope excursions in the Doushantuo Formation (South China) fingerprint complex redox-related processes in the Ediacaran Nanhua Basin. *Geochimica et Cosmochimica Acta* **261**: 191-209.

72. N. Truong, A. A. Monroe, C. R. Glein, A. D. Anbar, and J. I Lunine (2019). Decomposition of amino acids in water with application to in-situ measurements of Enceladus, Europa and other hydrothermally active icy ocean worlds. *Icarus* **329**: 140-147.

73. *F. Zhang, T. J. Algeo, Y. Cui, J. Shen, H. Song, H. Sano, H. D. Rowe, and A. D. Anbar (2019). Global-ocean redox variations across the Smithian-Spathian boundary linked to concurrent climatic and biotic changes. *Earth-Science Reviews* **195**: 147-168.

74. *F. Zhang, S. Xiao, S. J. Romaniello, D. Hardisty, C. Li, V. Melezhik, B. Pokrovsky, M. Cheng, W. Shi, T. M. Lenton, and A. D. Anbar (2019). Global marine redox changes drove the rise and fall of the Ediacara biota. *Geobiology* DOI: 10.1111/gbi.12359.

75. A. Anbar, S. Elgin, J. Jez, D. O'Dowd, B. Shapiro, and M. Zaman (2018). Improving societies' harassment policies (letter). *Science* **361**: 984-985.

76. *X. Chen, S. J. Romaniello, A. D. Herrmann, E. Samankassou, and A. D. Anbar (2018). Biological effects on uranium isotope fractionation ($^{238}U/^{235}U$) in primary biogenic carbonates. *Geochimica et Cosmochimica Acta* **240:** 1-10.

77. #A. D. Herrmann, G. W. Gordon, and A. D. Anbar (2018). Uranium isotope variations in a dolomitized Jurassic carbonate platform (Tithonian; Franconian Alb, Southern Germany). *Chemical Geology* **497**: 41-53.

78. #L. B. Horodyskyj, C. Mead, Z. Belinson, S. Buxner, S. Semken, and A. D. Anbar (2018). *Habitable Worlds:* Delivering on the promises of online education. *Astrobiology* **18**: 86-99. (https://doi.org/10.1089/ast.2016.1550)

79. A. I. Sheen, B. Kendall, C. T. Reinhard, R. A. Creaser, T. W. Lyons, A. Bekker, S. W. Poulton, and A. D. Anbar (2018). A model for the oceanic mass balance of rhenium and implications for the extent of Proterozoic ocean anoxia. *Geochimica et Cosmochimica Acta* **227**: 75-95.

80. *F. Zhang, F., S. J. Romaniello, T. Algeo, K. V. Lau, M. E. Clapham, S. Richoz, A. D. Herrmann, D. Smith, M. Horacek, and A. D. Anbar (2018). Multiple episodes of extensive

marine anoxia linked to global warming and continental weathering following the latest Permian mass extinction. *Science Advances* **4:** e1602921.

81. *F. Zhang, S. Xiao, B. Kendall, S. J. Romaniello, H. Cui, M. Meyer, G. J. Gilleaudeau, A. J. Kaufman, and A. D. Anbar. (2018) Extensive marine anoxia during the terminal Ediacaran Period. *Science Advances* **4**: eaan8983.

82. *F. Zhang, T. J. Algeo, S. J. Romaniello, Y. Cui, L. Zhao, Z-Q. Chen, and A. D. Anbar (2018). Congruent Permian-Triassic $\delta^{238}U$ records at Panthalassic and Tethyan sites: Confirmation of global-oceanic anoxia and validation of the U-isotope paleoredox proxy. *Geology* **46**: 327-330.

83. #W. Zheng, G. J. Gilleaudeau, L. C. Kah, and A. D. Anbar (2018). Mercury isotope signatures record photic zone euxinia in the Mesoproterozoic ocean. *Proceedings of the National Academy of Sciences* **115**: 10594-10599; 201721733; doi:10.1073/pnas.1721733115.

84. #W. Zheng, J. D. Demers, X. Lu, B. A. Bergquist, A. D. Anbar, J. D. Blum, B. Gu (2018). Mercury stable isotope fractionation during abiotic dark oxidation in the presence of thiols and natural organic matter. *Environmental Science and Technology* **53**: 1853-1862; doi: 10.1021/acs.est.8b05047

85. *X. Chen, S. J. Romaniello, and A. D. Anbar. (2017). Uranium isotope fractionation induced by aqueous speciation: Implications for U isotopes in marine $CaCO_3$ as a paleoredox proxy. *Geochimica et Cosmochimica Acta* **215**: 162-172.

86. S. J. Marsteller, K. J. Knudson, G. Gordon, and A. Anbar (2017). Biogeochemical reconstructions of life histories as a method to assess regional interactions: Stable oxygen and radiogenic strontium isotopes and Late Intermediate Period mobility on the Central Peruvian Coast. *J. Archaeol. Sci. Reports* **13**: 535-546.

87. M. Elrick, V. Polyak, T. J. Algeo, S. Romaniello, Y. Asmerom, A. D. Herrmann, A. D. Anbar, L., Zhao, and Z. Q. Chen (2017). Global-ocean redox variation during the middle-late Permian through Early Triassic based on uranium isotope and Th/U trends of marine carbonates. *Geology* **45.2**: 163-166.

88. B. Kendall, T. W. Dahl, and A. D. Anbar (2017). Good Golly, Why Moly? The Stable Isotope Geochemistry of Molybdenum. *Rev. Mineral. Geochem.* **82**: 683-732.

89. *V. Perera, C. Mead, S. Buxner, D. Lopatto, L. Horodyskyj, S. Semken, and A. D. Anbar (2017). Students in fully-online programs report more positive attitudes toward science than students in traditional, in-person programs. *CBE-Life Sciences Education.* **16**: ar60 doi:10.1187/cbe.16-11-0316

90. ¶H. Song, H. Song, T. J. Algeo, J. Tong, S. J. Romaniello, Y. Zhu, D. Chu, Y. Gong, and A. D. Anbar (2017). Uranium and carbon isotopes document global-ocean redox- productivity relationships linked to cooling during the Frasnian-Famennian mass extinction. *Geology* **45**: 887-890.

91. A. D. Anbar, C. B. Till, and M. A. Hannah (2016). Bridging the planetary divide. *Nature* **539**: 25-27.

92. A. D. Anbar, S. J. Romaniello, B. R. Allenby, and W. S. Broecker (2016). Addressing the Anthropocene. *Environmental Chemistry* **13**: 777. (Invited Rowland Tribute Series paper).

93. *X. Chen, S. J. Romaniello, A. D. Herrmann, L. E. Wasylenki, and A. D. Anbar (2016). Uranium isotope fractionation during coprecipitation with aragonite and calcite. *Geochimica et Cosmochimica Acta* **188**: 189-207.

94. N. R. Hinkel, P. A. Young, M. D. Pagano, S. J. Desch, A. D. Anbar, V. Adibekyan, S. Blanco-Cuaresma, J. K. Carlberg, E. D. Mena, F. Liu, and T. Nordlander (2016). A comparison of stellar elemental abundance techniques and measurements. *The Astrophysical Journal Supplement Series* doi:10.3847/0067-0049/226/1/4

95. *S. J. Romaniello, A. D. Herrmann, and A. D. Anbar (2016). Syndepositional diagenetic control of molybdenum isotope variations in carbonate sediments from the Bahamas. *Chemical Geology* **438**: 84-90.

96. S. K. Sahoo, N. J. Planavsky, G. Jiang, B. Kendall, J. D. Owens, X. Wang, X. Shi, A. D. Anbar, and T. W. Lyons (2016). Oceanic oxygenation events in the anoxic Ediacaran ocean. *Geobiology* 10.1111/gbi.12182

97. A. L. Wolfe, B. W. Stewart, R. C. Capo, R. Liu, D. A. Dzombak, G. W. Gordon, and A. D. Anbar (2016). Iron isotope investigation of hydrothermal and sedimentary pyrite and their aqueous dissolution products. *Chemical Geology* **427**: 73-82.

98. B. T. Cartledge, A. R. Marcotte, A. D. Anbar, P. Herckes, and B. J. Majestic (2015). The impact of particle size, relative humidity, and sulfur dioxide on iron solubility in simulated atmospheric marine aerosols. *Environmental Science & Technology* **49**: 7179-7187.

99. #M. B. Channon, G. W. Gordon, J. L. L. Morgan, J. L. Skulan, S. M. Smith and A. D. Anbar (2015). Using natural, stable calcium isotopes of human blood to detect and monitor changes in bone mineral balance. *Bone* **77:** 69-74.

100. B. Kendall, R. A. Creaser, C. Reinhard, T. W. Lyons, and A. D. Anbar (2015). Transient episodes of mild environmental oxygenation and oxidative continental weathering during the late Archean. *Science Advances* **1**: e1500777.

101. #B. Kendall, T. Komiya, T. W. Lyons, S. M. Bates, G. W. Gordon, S, J. Romaniello, and A. D. Anbar (2015). Uranium and molybdenum isotope evidence for an episode of widespread ocean oxygenation during the late Ediacaran Period. *Geochimica et Cosmochimica Acta* **156**: 173-193.

102. *M. Neveu, A. T. Poret-Peterson, A. D. Anbar, and J. J. Elser (2015). Ordinary stoichiometry of extraordinary microorganisms. *Geobiology* doi: 10.1111/gbi.12153

103. #S. J. Romaniello, M. P. Field, H. B. Smith, G. W. Gordon, M. H. Kim, and A. D. Anbar (2015). Fully automated chromatographic purification of Sr and Ca for isotopic analysis. *Journal of Analytical Atomic Spectrometry* **30**: 1906-1912.

104. E. E. Stüeken, R. Buick, and A. D. Anbar (2015). Selenium isotopes support free O_2 in the latest Archean. *Geology* **43**: 259-262.

105. #G. W. Gordon, J. Monge, M. B. Channon, Q. Wu, J. L. Skulan, A. D. Anbar and R. Fonseca (2014). Predicting multiple myeloma disease activity by analyzing natural calcium isotopic composition. *Leukemia* **28**: 2112; doi:10.1038/leu.2014.193.

106. ¶K. T. Goto, A. D. Anbar, G. W. Gordon, S. J. Romaniello, G. Shimoda, Y. Takaya, A. Tokumaru, R. Nozaki, K. Suzuki, S. Machida, T. Hanyu and A. Usui (2014). Uranium isotope systematics of ferromanganese crusts in the Pacific Ocean: Implications for the marine $^{238}U/^{235}U$ isotope system. *Geochimica et Cosmochimica Acta* **146**: 43-58.

107. *M. Neveu, A. T. Poret-Peterson, Z. M. P. Lee, A. D. Anbar and J. J. Elser (2014). Prokaryotic cells separated from sediments are suitable for elemental composition analysis. *Limnology and Oceanography: Methods* **12:** 519-529.

108. P. A. Young, S. J. Desch, A. D. Anbar, R. Barnes, N. R. Hinkel, R. Kopparapu, N. Madhusudhan, N. Monga, M. D. Pagano, M. A. Riner, E. Scannapieco, S-H. Shim and A. Truitt (2014). Astrobiological stoichiometry. *Astrobiology* **14**: 603-626.

109. S. J. Desch, P. A. Young, A. D. Anbar, N. Hinkel, M. Pagano, A. Truitt and M. Turnbull (2014). Report on a NASA Astrobiology Institute-funded Workshop Without Walls: Stellar Stoichiometry. *Astrobiology* doi: 10.1089/ast.2014.1157.

110. C. P. McKay, A. D. Anbar, C. Porco and P. Tsou (2014). Follow the plume: the habitability of Enceladus. *Astrobiology* doi: 10.1089/ast.2014.1158.

111. T. F. Nägler, A. D. Anbar, C. Archer, T. Goldberg, G. W. Gordon, N. D. Greber, C. Siebert, Y. Sohrin, and D. Vance (2014). Proposal for an international molybdenum isotope measurement standard and data representation. *Geostandards and Geoanalytical Research* **38**: 149-151.

112. *J. B. Glass, A. Chappaz, B. Eustis, A. C. Heyvaert, D. Waetjen, H. E. Hartnett and A. D. Anbar (2013). Molybdenum geochemistry in a seasonally dysoxic Mo-limited lacustrine ecosystem. *Geochimica et Cosmochimica Acta* **114**: 204-219.

113. *J. B. Glass, A. T. Poret-Peterson, F. Wolfe-Simon and A. D. Anbar (2013). Molybdenum limitation induces expression of the molybdate-binding protein Mop in a freshwater nitrogen-fixing cyanobacterium. *Advances in Microbiology* **3**: 9-15.

114. T. Goldberg, G. Gordon, G. Izon, C. Archer, C. R. Pearce, J. McManus, A. D. Anbar and M. Rehkämper (2013). Resolution of inter-laboratory discrepancies in Mo isotope data: an intercalibration. *Journal of Analytical and Atomic Spectrometry* doi: 10.1039/C3JA30375F.

115. #B. Kendall, G. A. Brennecka, S. Weyer and A. D. Anbar (2013). Uranium isotope fractionation suggests oxidative uranium mobilization at 2.50 Ga. *Chemical Geology* **362**: 105-114.

116. Y. Marusenko, J. Shipp, G. A. Hamilton, J. L.L. Morgan, M. Keebaugh, H. Hill, A. Dutta, X. Zhuo, N. Upadhyay, J. Hutchings, P. Herckes, A. D. Anbar, E. Shock and H. E. Hartnett (2013). Bioavailability of nanoparticulate hematite to *Arabidopsis thaliana*. *Environmental Pollution* **174**: 150-156.

117. *C. Mead, J. R. Lyons, T. M. Johnson and A. D. Anbar (2013). Unique Hg stable isotope signatures of compact fluorescent lamp-sourced Hg. *Environmental Science and Technology* **47**: 2542-2547.

118. *C. Mead, P. Herckes, B. J. Majestic and A. D. Anbar (2013). Source apportionment of aerosol iron in the marine environment using iron isotope analysis. *Geophysical Research. Letters* **40**: 5722-5727.

119. *S. Romaniello, A. D. Herrmann and A. D. Anbar (2013). Uranium concentrations and $^{238}U/^{235}U$ isotope ratios ($^{238}U/^{235}U$) in modern carbonates from the Bahamas: assessing a novel paleoredox proxy. *Chemical Geol*ogy **362**: 305-316.

120. C. Scott, N. J. Planavsky, C. L. DuPont, B. Kendall, B. C. Gill, L. J. Robbins, K. F. Husband, G. L. Arnold, B. A. Wing, S. W. Poulton, A. Bekker, A. D. Anbar, K. O. Konhauser and T. W. Lyons (2013). Bioavailability of zinc in marine systems through time. *Nature Geoscience* **6**: 125-128.

121. *G. L. Arnold, T. W. Lyons, G. W. Gordon and A. D. Anbar (2012). Extreme change in sulfide concentrations in the Black Sea during the Little Ice Age reconstructed using molybdenum isotopes. *Geology* **40**: 595-598.

122. A. Chappaz, T. W. Lyons, G. Gordon and A. D. Anbar (2012). Isotopic fingerprints of anthropogenic molybdenum in lake sediments. *Environmental Science and Technology* **46**: 10934-10940.

123. #A. D. Herrmann, B. Kendall, T. J. Algeo, G. W. Gordon, L. E. Wasylenki and A. D. Anbar (2012). Anomalous molybdenum isotope trends in Upper Pennsylvanian euxinic facies: Significance for use of $\delta^{98}Mo$ as a global marine redox proxy. *Chemical Geology* **324-325**: 87-98.

124. *J. L. L. Morgan, J. L. Skulan, G. W. Gordon, S. J. Romaniello, S. M. Smith and A. D. Anbar (2012). Rapidly assessing changes in bone mineral balance using natural stable calcium isotopes. *Proceedings of the National Academy of Sciences* **109**: 9989-9994.

125. J. D. Owens, T. W. Lyons, X. Li, K. G. Macleod, G. Gordon, M. M. M. Kuypers, A. Anbar, W. Kuhnt and S. Severmann. (2012). Iron isotope and trace metal records of iron cycling in the proto-North Atlantic during the Cenomanian-Turonian oceanic anoxic event (OAE-2). *Paleoceanography* **27**, PA3223, 13 pp.

126. ¶S. K. Sahoo, N. J. Planavsky, B. Kendall, X. Wang, X Shi, C. Scott, A. D. Anbar, T. W. Lyons and G. Jiang (2012). Ocean oxygenation in the wake of the Marinoan glaciation. *Nature* **489**: 546-549.

127. P. Tsou, D. E. Brownlee, C. P. McKay, A. D. Anbar, H. Yano, K. Altwegg, L. W. Beegle, R. Dissly, N. J. Strange and I. Kanik (2012). LIFE: Life Investigation For Enceladus, A Sample Return Mission Concept in Search for Evidence of Life. *Astrobiology* **12**: 730-742.

128. *G. A. Brennecka, A. D. Herrmann, T. J. Algeo and A. D. Anbar (2011). Rapid expansion of oceanic anoxia immediately before the end-Permian extinction. *Proceedings of the National Academy of Sciences* **108**: 17631-17634; doi/10.1073/pnas.1106039108.

129. ¶T. W. Dahl, D. E. Canfield, M. T. Rosing, R. Frei, G. W. Gordon, A. H. Knoll and A. D. Anbar (2011). Molybdenum evidence for expansive sulfidic water masses in ~750 Ma oceans. *Earth and Planetary Science Letters* **311**: 264-274.

130. ¶T. W. Dahl, E. U. Hammarlund, A. D. Anbar, D. P. G. Bond, B. C. Gill, G. W. Gordon, A. H. Knoll, A. T. Nielsen, N. H. Schovsbo and D. E. Canfield (2011) Reply to Butterfield: Devonian rise in atmospheric oxygen correlated to the radiations of terrestrial plants and large predatory fish. *Proceedings of the National Academy of Sciences* **108**: E29; doi: 10.1073/pnas.1018818108.

131. *J. L. Morgan, G. W. Gordon, C. Arrua, J. Skulan, T. D. Bullen and A. D. Anbar (2011). High precision measurement of variations in calcium isotope ratios in urine by multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS). *Analytical Chemistry* **83**: 6956-6962.

132. #B. Kendall, G. W. Gordon, S. W. Poulton and A. D. Anbar (2011). Molybdenum isotope constraints on the extent of late Proterozoic ocean euxina. *Earth and Planetary Science Letters* **307**: 450-460.

133. #L. E. Wasylenki, C. L. Weeks, J. R. Bargar, T. G. Spiro, J. R. Hein and A. D. Anbar (2011). The molecular mechanism of Mo isotope fractionation during adsorption to birnessite. *Geochimica et Cosmochimica Acta* **75**: 5019-5031.

134. E. S. Boyd, A. D. Anbar, S. Miller, T. L. Hamilton, M. Lavin and J. W. Peters (2011). A late methanogen origin for molybdenum-dependent nitrogenase. *Geobiology* **9**: 221-232. doi: 10.1111/j.1472-4669.2011.00278.x

135. *G. Brennecka, L. E. Wasylenki, S. Weyer and A. D. Anbar (2011). Uranium isotope fractionation during adsorption to manganese oxides. *Environmental Science and Technology* **45**: 1370-1375. dx.doi.org/10.1021/es103061v

136. ¶B. D. Duval, P. Dijkstra, S. A. Natali, J. P. Megonigal, M. E. Ketterer, B. G. Drake, M. T. Lerdau, G. Gordon, A. D. Anbar and B. A. Hungate (2011). Plant-soil distribution of potentially toxic elements in response to elevated atmospheric CO_2. *Environmental Science and Technology.* **45**: 2570-2574. dx.doi.org/10.1021/es102250u

137. L. J. Liermann, R. Mathur, L. E. Wasylenki, J. Nuester, A. D. Anbar and S. L. Brantley (2011). Extent and isotopic composition of Fe and Mo release from two Pennsylvania shales in the presence of organic ligands and bacteria. *Chemical Geology* **281**: 167-180.

138. F. Wolfe-Simon, J. Switzer Blum, T. R. Kulp, G. W. Gordon, S. E. Hoeft, J. Pett-Ridge, J. F. Stolz, S. M. Webb, P. K. Weber, P. C. W. Davies, A. D. Anbar and R. S. Oremland (2011). RETRACTED: A bacterium that can grow by using arsenic instead of phosphorus. *Science* **332**: 1163 – 1166.

139. F. Wolfe-Simon, J. Switzer Blum, T. R. Kulp, G. W. Gordon, S. E. Hoeft, J. Pett-Ridge, J. F. Stolz, S. M. Webb, P. K. Weber, P. C. W. Davies, A. D. Anbar and R. S. Oremland (2011). Response to Comments on "A bacterium that can grow by using arsenic instead of phosphorus". *Science* doi: 10.1126/science.1202098

140. R. Raiswell, C. T. Reinhard, A. Derkowski, J. Owens, S. H. Bottrell, A. D. Anbar and T. W. Lyons (2011). Formation of syngenetic and early diagenetic iron minerals in the late Archean Mt. McRae Shale, Hamersley Basin, Australia: New insights on the patterns, controls and paleoenvironmental implications of authigenic mineral formation. *Geochimica et Cosmochimica Acta* **17**: 1072-1087; doi:10.1016/j.gCA2010.11.013.

141. *G. A. Brennecka, S. Weyer, M. Wadhwa, P. Janney, A. D. Anbar and J. Zipfel (2010). $^{238}U/^{235}U$ variations in meteorites: extant ^{247}Cm and implications for Pb-Pb dating. *Science* **327**: 449-451; doi: 10.1126/science.1180871.

142. *G. A. Brennecka, L.E. Borg, I. D. Hutcheon, M. A. Sharp and A. D. Anbar (2010). Natural variations in uranium isotope ratios of uranium ore concentrates: Understanding the $^{238}U/^{235}U$ fractionation mechanism. *Earth and Planetary. Science Letters.* **291**: 228-233; doi: 10.1016/j.epsl.2010.01.023.

143. ¶T. W. Dahl, A. D. Anbar, G. W. Gordon, M. T. Rosing, R. E. Frei and D. E. Canfield (2010). The behavior of molybdenum and its isotopes across the chemocline and in the sediments of sulfidic Lake Cadagno, Switzerland. *Geochimica et Cosmochimica Acta* **74**: 144-163; doi: 10.1016/j.gCA2009.09.018.

144. ¶T. W. Dahl, E. U. Hammarlund, A. D. Anbar, D. P. G. Bond, B. C. Gill, G. W. Gordon, A. H. Knoll, A. T. Nielsen, N. H. Schovsbo and D. E. Canfield (2010) Devonian rise in atmospheric oxygen correlated to the radiations of terrestrial plants and large predatory fish. *Proceedings of the National Academy of Sciences* **107**: 17911-17915; doi: 10.1073/pnas.1011287107.

145. *Y. Duan, A. D. Anbar, G. L. Arnold, T. W. Lyons, G. W. Gordon and B. Kendall (2010). Molybdenum isotope evidence for mild environmental oxygenation before the Great Oxidation Event. *Geochimica et Cosmochimica Acta* **74**: 6655-6668; doi: 10.1016/j.epsl.2009.11.052.

146. *Y. Duan, A. D. Anbar, G. Gordon, S. Severmann, T. W. Lyons and B. Sageman (2010). Isotopic evidence for Fe cycling and repartitioning in ancient oxygen-deficient settings: Examples from black shales of the mid-to-late Devonian Appalachian basin. *Earth and Planetary Science Letters.* **290**: 244-253; doi: 10.1016/j.epsl.2009.11.052.

147. *J. Glass, F. Wolfe-Simon, J. J. Elser and A. D. Anbar (2010). Molybdenum–nitrogen co-limitation in freshwater and coastal heterocystous cyanobacteria. *Limnology and Oceanography* **55**: 667-676.

148. #B. Kendall, A. J. Kaufman, C. Reinhard, T. W. Lyons and A. D. Anbar (2010). Pervasive oxygenation along late Archean ocean margins. *Nature Geoscience* **3**: 647-652; doi: 10.1038/NGEO942.

149. K. J. Knudson, H. M. Williams, J. E. Buikstra, P. D. Tomczak, G. W. Gordon and A. D. Anbar (2010). Introducing $\delta^{88/86}$Sr analysis in archaeology: a demonstration of the utility of strontium isotope fractionation in paleodietary studies. *Journal of Archeological Science* **37**: 2352-2364; doi:10.1016/j.jas.2010.04.009.

150. R. Mathur, S. Brantley, A. Anbar, F. Munizaga, V. Maksaec, R. Newberry, J. Vervoort and G. Hart (2010). Variation of Mo isotopes from molybdenite in high-temperature hydrothermal ore deposits. *Mineral Deposita* **45**: 43-50; doi: 10.1007/s00126-009-0257-z.

151. C. Montoya-Pino, S. Weyer, A. D. Anbar, J. Pross, W. Oschmann, B. van de Schootbrugge and H. W. Arz (2010). Global enhancement of ocean anoxia during Oceanic Anoxic Event 2: A quantitative approach using U isotopes. *Geology* **38**: 315-318; doi: 10.1130/G30652.1.

152. *J. L. Morgan, L. E. Wasylenki and A. D. Anbar (2010). Fe isotope fractionation during equilibration of Fe-organic complexes. *Environmental Science and Technology* **44**: 6095-6101; doi: 10.1021/es100906z.

153. L. Pratt et al. (2010). The Mars astrobiology explorer-cacher (MAX-C): A potential rover mission for 2018. *Astrobiology* **10**: 127-163; doi: 10.1089/ast.2010.0462.

154. *H. Beraldi-Campesi, H. E. Hartnett, A. D. Anbar, G. W. Gordon and F. Garcia-Pichel (2009). Effects of biological soil crusts on soil elemental concentrations: implications for biogeochemistry and as traceable biosignatures of ancient life on land. *Geobiology* **7**: 348-359.

155. #G. W. Gordon, T. W. Lyons, G. L. Arnold, J. E. Roe, B. B. Sageman and A. D. Anbar (2009). When do black shales tell molybdenum isotope tales? *Geology* **37**: 535-538.

156. T. W. Lyons, A. D. Anbar, S. Severmann, C. Scott and B. C. Gill (2009). Tracking euxinia in the ancient ocean: a multiproxy perspective and Proterozoic case study. *Annual Review of Earth and Planetary Sciences* **37**, 507-534.

157. #B. Majestic, A. D. Anbar and P. Herckes (2009). Measuring natural variations of iron isotopic composition in atmospheric aerosols for use in source-apportionment studies. *Environmental Science and Technology* **43**: 4327-4333.

158. #B. J. Majestic, A. D. Anbar and P. Herckes (2009). Elemental and iron isotopic composition of aerosols collected in a parking structure. *Science of the Total Environment* **407**: 5104-5109.

159. J. Garvin, R. Buick, A. D. Anbar, G. L. Arnold and A. J. Kaufman (2009). Isotopic evidence for an aerobic nitrogen cycle in the latest Archean. *Science* **323**: 1045-1048.

160. *J. B. Glass, F. Wolfe-Simon and A. D. Anbar (2009). Coevolution of marine metal availability and photoautotrophic nitrogen assimilation. *Geobiology* **7**: 100-123; doi 10.1111/j.1472-4669.2009.00190.x.

161. ¶B. Kendall, R. A. Creaser, G. W. Gordon and A. D. Anbar (2009). Re-Os, Mo, and Fe isotope systematics of black shales from the Proterozoic Velkerri and Wollogorang Formations, McArthur Basin, Northern Australia. *Geochimica et Cosmochimica Acta* **73**: 2534-2558.

162. J. A. Mikucki, A. Pearson, D. T. Johnston, A. V. Turchyn, J. Farquhar, D. P. Schrag, A. D. Anbar, J. C. Priscu and P. A. Lee (2009). A contemporary microbially maintained subglacial ferrous 'ocean'. *Science* **324**: 397 – 400.

163. H. Ohmoto, B. Runnegar, L. R. Kump, M. L. Fogel, B. Kamber, A. D. Anbar, P. L. Knauth, D. R. Lowe, D. Y. Sumner and Y. Watanabe (2009). Biosignatures in ancient rocks: a summary of discussions at a field workshop on biosignatures in ancient rocks. *Astrobiology* **8**: 883-907.

164. C. Reinhard, R. Raiswell, C. Scott, A. D. Anbar and T. W. Lyons (2009). A late Archean sulfidic sea stimulated by early oxidative weathering of the continents. *Science* **326**: 713-716.

165. ¶U. Ryb, A. Matthews, Y. Erel, G. Gordon and A. D. Anbar (2009). Large molybdenum isotope variations in a continental rift setting. *Geology* **37**: 463-466.

166. ¶S. Severmann and A. D. Anbar (2009). Reconstructing paleoredox conditions through a multi-tracer approach: the key to the past is the present. *Elements* **5**: 359-364.

167. #F. Wolfe-Simon, P. C. W. Davies and A. D. Anbar (2009). Did nature also choose arsenic? *International Journal of Astrobiology* doi:10.1017/S1473550408004394.

168. A. D. Anbar (2008). Elements and evolution. *Science* **322**: 1481-1483.

169. A. D. Anbar and G. W. Gordon (2008). Redox renaissance. *Geology* **36**: 271-272.

170. ¶C. Scott, T. W. Lyons, A. Bekker, Y. Shen, S. W. Poulton, X. Chu and A. D. Anbar (2008). Tracing the stepwise oxygenation of the Proterozoic ocean. *Nature* **452**: 456-459.

171. O. F. Overinde, C. L. Weeks, A. D. Anbar and T. G. Spiro (2008). Solution structure of molybdic acid from Raman spectroscopy and DFT analysis. *Inorganic Chimica Acta* **361**: 1000-1007.

172. ¶S. Severmann, T. W. Lyons, A. D. Anbar, J. McManus and G. Gordon (2008). Modern iron isotope perspective on the benthic iron shuttle and the redox evolution of ancient oceans. *Geology* **36**: 487-490.

173. #L. E. Wasylenki, B. A. Rolfe, C. Weeks, T. Spiro and A. D. Anbar (2008). Experimental investigation of the effects of temperature and ionic strength on Mo isotope fractionation during adsorption to manganese oxides. *Geochimica et Cosmochimica Acta* **72**: 5997-6005.

174. ¶S. Weyer, A. D. Anbar, A. Gerdes, G. W. Gordon, T. J. Algeo and E. A. Boyle (2008). Natural fractionation of $^{238}U/^{235}U$. *Earth and Planetary Science Letters* **72**: 345-359.

175. P. E. Carrigan, J. G. Hentz, G. Gordon, J. L. Morgan, M. Raimondo, A. D. Anbar and L. J. Miller (2007). Distinctive heavy metal composition of pancreatic juice in patients with pancreatic carcinoma. *Cancer, Epidemiology, Biomarkers and Prevention* **16**: 2656-2663.

176. A. D. Anbar, Y. Duan, T. W. Lyons, G. L. Arnold, B. Kendall, R. A. Creaser, A. J. Kaufman, G. Gordon, C. Scott, J. Garvin and R. Buick (2007). A whiff of oxygen before the Great Oxidation Event? *Science* **317**: 1903-1906. (https://doi.org/10.1126/science.1140325)

177. A. J. Kaufman, D. T. Johnston, J. Farquhar, A. L. Masterson, T. W. Lyons, S. Bates, A. D. Anbar, G. L. Arnold, J. Garvin and R. Buick (2007). Late Archean biospheric oxygenation and atmospheric evolution. *Science* **317**: 1900-1903.

178. #L. E. Wasylenki, A. D. Anbar, L. J. Liermann, R. Mathur, G. W. Gordon and S. L. Brantley (2007). Isotope fractionation during microbial metal uptake measured by MC-ICP-MS. *Journal of Analytical and Atomic Spectroscopy* **22**: 905-910.

179. L. Liermann, E. Hausrath, A. D. Anbar and S. L. Brantley (2007). Assimilatory and dissimilatory processes of microorganisms affecting metals in the environment. *Journal of Analytical and Atomic Spectroscopy* **22**: 867-877.

180. A. D. Anbar and O. Rouxel (2007). Metal stable isotopes in paleoceanography. *Annual Review of Earth and Planetary Sciences* **35**: 717-746.

181. K. O. Konhauser, L. Amskold, S. V. Lalonde and A. Anbar (2007). Decoupling photochemical Fe(II) oxidation from shallow-water BIF deposition. *Earth and Planetary Science Lett*ers **258**: 87-100.

182. J. Skulan, T. Bullen, A. D. Anbar, J. E. Puzas, L. Shackelford, A. LeBlanc and S. Smith (2007). Natural calcium isotopic composition of urine as a marker of bone mineral balance. *Clinical Chemistry* **53**: 1155-1158.

183. C. L. Weeks, A. D. Anbar, L. E. Wasylenki and T. G. Spiro (2007). DFT analysis of molybdenum isotope fractionation. *Journal of Physical Chemistry A* **111**: 12434-12438. See also correction in **112**: 10703 (2008).

184. S. Weyer, A. D. Anbar, G. P. Brey, C. Munker, K. Mezger and A. B. Woodland (2007). Fe-isotope fractionation during partial melting on Earth and the current view on the Fe-isotope budgets of the planets (Reply to the comment of F. Poitrasson and to the comment of B.L. Beard and C.M. Johnson on "Iron isotope fractionation during planetary differentiation" by S. Weyer,

A. D. Anbar, G. P. Brey, C. Munker, K. Mezger and A. B. Woodland). *Earth and Planetary Science Letters* **56**: 638-646.

185. A. D. Anbar, A. Jarzecki and T. Spiro (2005). Theoretical investigation of iron isotope fractionation between $Fe(H_2O)_6^{3+}$ and $Fe(H_2O)_6^{2+}$: implications for iron stable isotope geochemistry. *Geochimica et Cosmochimica Acta* **69**: 825-837.

186. A. D. Anbar, G. L. Arnold, T. W. Lyons and J. Barling (2005). Response to comment on "Molybdenum isotope evidence for widespread anoxia in mid-Proterozoic oceans". *Science* **309**: doi:10.1126/science.1105521.

187. B. M. Jakosky, A. D. Anbar, D. Des Marais, D. Morrison and N. R. Pace (2005). Don't dismiss astrobiology. *Science* **308**: 496.

188. L. J. Liermann, A. Marin, V. LeBron, R. L. Guynn, J. Barling, A. D. Anbar and S. L. Brantley (2005). Metal-targeted dissolution of silicates by soil bacteria. *Chemical Geology* **220**: 285-302.

189. S. Weyer, C. Münker, G. Brey, A. Woodland, K. Metzger and A. D. Anbar (2005). Iron isotope fractionation during planetary differentiation. *Earth and Planetary Science Letters* **240**: 251-264.

190. A. D. Anbar (2004). Molybdenum stable isotopes: Observations, interpretations and directions. *Reviews in Mineralogy and Geochemistry* **55**: 429-454.

191. [*]G. L. Arnold, A. D. Anbar, J. Barling and T. W. Lyons (2004). Molybdenum isotope evidence of widespread anoxia in mid-Proterozoic oceans. *Science* **304**: 87-90.

192. S. L. Brantley, L. J. Liermann, A. D. Anbar, G. A. Icopini, R. L. Guynn and J. Barling (2004). Fe isotopic fractionation during mineral dissolution with and without bacteria. *Geochimica et Cosmochimica Acta* **68**: 3189-3204.

193. A. Jarzecki, A. D. Anbar and T. Spiro (2004). DFT investigation of vibrational spectra of $Fe(H_2O)_6^{3+}$ and $Fe(H_2O)_6^{2+}$. *Journal of Physical Chemistry A* **108**: 2726-2732.

194. G. A. Icopini, S. Ruebush, M. Tien, A. D. Anbar and S. L. Brantley (2004). Iron isotope fractionation during microbial reduction of iron: the importance of adsorption. *Geology* **32**: 205-208.

195. A. D. Anbar (2004). Iron stable isotopes: beyond biosignatures. *Earth and Planetary Science Letters (Frontiers)* **217**: 223-236.

196. [*]G. L. Arnold, S. Weyer and A. D. Anbar (2004). Iron isotope variations in natural materials measured using high mass resolution MC-ICP-MS. *Analytical Chemistry* **76**: 322-327.

197. [#]J. Barling and A. D. Anbar (2004). Molybdenum isotope fractionation during adsorption by manganese oxides. *Earth and Planetary Science Letters* **217**: 315-329.

198. O. Katz, M. Beyth, N. Mille, R. Stern, D. Avigad, A. R. Basu and A. D. Anbar (2004). A Late Neoproterozoic (~630 Ma) Boninitic Suite from southern Israel: Implications for the consolidation of Gondwanaland. *Earth and Planetary Science Letters.* **218**: 475-490.

199. *J. E. Roe, A. D. Anbar and J. Barling (2003). Nonbiological fractionation of Fe isotopes: Evidence of an equilibrium isotope effect. *Chemical Geology* **195**: 69-85.

200. A. D. Anbar and A. H. Knoll (2002). Proterozoic ocean chemistry and evolution: A bioinorganic bridge? *Science* **297**, 1137-1142.

201. #J. Barling, G. L. Arnold and A. D. Anbar (2001). Natural mass-dependent variation in the isotopic composition of molybdenum. *Earth and Planetary Science Letters* **193**: 447-457.

202. M. Sharma, M. L. Polizzotto and A. D. Anbar (2001). Iron isotopes in hydrothermal fluids at the Juan de Fuca ridge. *Earth and Planetary Science Letters* **194**: 39-51.

203. A. D. Anbar, K. A. Knab and J. Barling (2001). Precise determination of mass-dependent variations in the isotopic composition of Mo using MC-ICP-MS. *Analytical Chemistry* **73**: 1425-1431.

204. A. D. Anbar, K. J. Zahnle, G. L. Arnold and S. J. Mojzsis (2001). Extraterrestrial iridium, sediment accumulation and the habitability of the early Earth's surface. *Journal of Geophysical Research* **106**: 3219-3236.

205. P. A. Karam, S. A. Leslie and A. D. Anbar (2001). The effects of changing atmospheric oxygen concentrations and background radiation levels on radiogenic DNA damage rates. *Health Physics* **81**: 545-553.

206. A. D. Anbar (2001). Iron isotope biosignatures: promise and progress. *EOS* **83**: 173, 178-179.

207. A. D. Anbar, J. E. Roe, J. Barling and K. H. Nealson (2000). Nonbiological fractionation of iron isotopes. *Science* **288**: 126-128. (https://doi.org/10.1126/science.288.5463.126)

208. A. D. Anbar, D. A. Papanastassiou and G. J. Wasserburg (1997). The determination of iridium in natural waters by clean chemical preconcentration and negative thermal ionization mass spectrometry. *Analytical Chemistry* **69**: 2444-2450.

209. A. D. Anbar, G. J. Wasserburg, D. A. Papanastassiou and P. S. Andersson (1996). Iridium in natural waters. *Science* **273**: 1524-1528.

210. A. D. Anbar, F. Chavez and Y. L. Yung (1996). Methyl bromide: Ocean sources, ocean sinks and climate sensitivity. *Global Biogeochemical Cycles* **10**: 175-190.

211. H. Nair, M. Allen, A. D. Anbar, Y. L. Yung and R. T. Clancy (1994). A photochemical model of the Martian atmosphere. *Icarus* **111**: 124-150.

212. A. D. Anbar and M. Allen (1993). Photodissociation in the atmosphere of Mars: Impact of high resolution, temperature-dependent CO_2 cross section measurements. *Journal of Geophysical. Research – Planets* **98**: 10,925-10,931.

213. A. D. Anbar, M-T. Leu, H. A. Nair and Y. L. Yung (1993). The adsorption of HO_x on aerosol surfaces: Implications for the atmosphere of Mars. *Journal of Geophysical. Research – Planets* **98**: 10,933-10,940.

214. A. D. Anbar, D. A. Papanastassiou, R. A. Creaser and G. J. Wasserburg (1992). Rhenium in seawater: Confirmation of generally conservative behavior. *Geochimica et Cosmochimica Acta* **56**: 4099-4103.

215. A. D. Anbar and H. D. Holland (1992). The photochemistry of manganese and the origin of banded iron formations. *Geochimica et Cosmochimica Acta* **56**: 2595-2603.

216. M-T. Leu, J. Blamont, A. D. Anbar, L. F. Keyser, and S. P. Sander (1992). Adsorption of CO on water-ice and oxide surfaces: Implications for the Martian atmosphere. *Journal of Geophysical. Research – Planets* **97**: 2621-2627.

Invited Chapters, Reports, Reviews, White Papers, Open Archive Submissions, Etc. (not refereed):

1. J. Bimm, M. Voytek, C. Scharf, L. Billings, B. Suldovsky, F. Wolfe-Simon, M. L. Cable, S. K. Yeo, M. A. Xenos, A. Segura, A. Berea, A. D. Anbar, M. Kaufman, V. Meadows, H. Graham, K. Cartier, S. Z. Sheikh, J. N. Nováková, I. Ockert, and J. M. Determann (2025). Communicating Discoveries in the Search for Life in the Universe Workshop Report *Astrobiology*, **25**: 743. (https://doi.org/10.1177/15311074251387636)

2. *C. M. Ostrander, A. W. Heard, B. Kendall, R. W. Nicklas, A. Bekker, A. C. Johnson, A. D. Anbar, and T. W. Lyons. (2026). Oxygenating Earth. The Archean Earth (2nd edition). Elsevier, 311-332. (https://doi.org/10.1016/B978-0-323-95547-8.00021-5)

3. #K. I. Rico, A. K. Garcia, M. A. Saito, B. Kaçar, and A. D. Anbar (2025). Mysteries of metallome evolution: Integrating insights from the Earth and life sciences. In: *Treatise on Geochemistry (3rd Edition), Volume 5*, A. D. Anbar and D. Weis, eds., Elsevier, pp. 337 – 364. (https://doi.org/10.1016/B978-0-323-99762-1.00143-1)

4. M. Sobol, H. Rucker, E. Libby, B. Kaçar, and A. D. Anbar (2024). Ecological resource competition as a driver of metallome evolution. *bioRxiv preprint* (https://doi.org/10.1101/2024.12.11.627971)

5. D. J. Des Marais, M. C. Farmer, A. D. Anbar, J. Zaloumis, S. Shkolyar, C. Estrada, and S. L. Cady (2023). Jack Dwayne Farmer: April 18, 1947–February 22, 2023. *Astrobiology*, **23**: 921-925.

6. B. Kaçar, A. D. Anbar, A. K. Garcia, L. C. Seefeldt, Z. R. Adam, and K. O. Konhauser (2021). Between a Rock and a Living Place: Natural Selection of Elements and the Search for Life in the Universe. *Bulletin of the American Astronomical Society* **53**: 210.

7. R. Kopparapu, G. Arney, S. Domagal-Goldman, E. Schwieterman, H. Hartnett, N. Kiang, E. Sneed, C. Reinhard, C. Dong, E. Hébrand, A. Anbar, N. Santos, N. Turner (2021). Strange New Worlds: Comparative Planetology of Exoplanets and the Solar System. *Bulletin of the American Astronomical Society* **53**: 106.

8. M. Neveu, A. D. Anbar, A. Davila, D. P. Glavin, S. M. MacKenzie, C. Phillips-Lander, B. Sherwood, Y. Takano, P. Willians, H. Ysano (2021). Returning Samples from Enceladus for Life Detection. *Bulletin of the American Astronomical Society* **53**: 052.

9. C. Mead, A. D. Anbar, L. B. Horodyskyj, and D. Bratton (2020). "Education Through Exploration: A model for using adaptive learning to teach laboratory science online". In: A*stronomy Education Volume 1: Online Formal and Informal Learning,* C. Impey and M. Wenger, eds. IOP Publishing.

10. T. K. Lowenstein, B. Kendall and A. D. Anbar (2013). The geologic history of seawater, Chapter 8.21. In: *Treatise on Geochemistry 2nd Edition,* H. D. Holland and K. K. Turekian, eds. Elsevier, pp. 569 – 621.

11. A. D. Anbar (2012). A coevolutionary tale: a review of *The Story of Earth* by R. Hazen. *Science* **337**: 1606.

12. #B. Kendall, A. D. Anbar, A. Kappler and K. O. Konhauser (2012). Chapter 6: The Global Iron Cycle. *Fundamentals of Geobiology*, A. H. Knoll, D. E. Canfield, and K. O. Konhauser, eds. Blackwell, pp. 65-92.

13. M. F. Westall, A. Anbar, W. Fischer and L. Kump, (2012). The great oxidation event: an expert discussion on the causes, the processes, and the still unknowns. *Astrobiology*, **12**: 1157-1162.

14. A. D. Anbar and S. Severmann (2011). Isotope Fractionation (Metal). *Encyclopedia of Geobiology*, J. Reitner and V. Thiel, eds. Springer, pp. 502-511.

15. A. D. Anbar and S. Severmann (2011). Transition Metals and their Isotopes. *Encyclopedia of Astrobiology*, M. Gargaud, ed. Springer, pp. 1703-1708.

16. Hamilton, V. E., Anbar, A. D, Budney, C. J., Mellon, M. T., Mischna, M. A., Righter, K. (2011) Recipe for Success: Research and Technology Programs as Key Ingredients of the Mars Exploration Program, Final Report of the Supporting Research and Technology Science Analysis Group (SRT SAG), 17 pp., posted January 12, 2011, by the Mars Exploration Program Analysis Group (MEPAG) at: http://mepag.jpl.nasa.gov/reports/.

17. C. S. Romanek, B. Beard, A. Anbar and C T.F. Andrus (2010). Non-traditional stable isotopes in the environmental sciences. In *Environmental Isotopes in Bioremediation and Microbial Degradation Processes,* (eds.) C.M. Aelion, P. Hohener, D. Hunkeler and R. Aravena. CRC Press LLC, Boca Raton, FL, 385-435.

18. Anbar, A. D., Grinspoon, D., Solomon, S. C. and Taylor, G. J. (2009). Astrobiology Research Priorities for Mercury, Venus and the Moon: A White Paper for the 2009 – 2011 Planetary Science Decadal Survey. http://www8.nationalacademies.org/ssbsurvey/publicview.aspx

19. Pratt, L.M., C. Allen, A.C. Allwood, A. Anbar, S.K. Atreya, D.W. Beaty, M.H. Carr, J.A. Crisp, D.J. Des Marais, J.A. Grant, D.P. Glavin, V.E. Hamilton, K. Herkenhoff, V. Hipkin, B. Sherwood Lollar, T.M. McCollom, A.S. McEwen, S.M. McLennan, R.E. Milliken, D.W. Ming, G.G. Ori, J. Parnell, F. Poulet, C.G. Salvo, F. Westall, C.W. Whetsel, and M.G. Wilson (2009) Mars Astrobiology Explorer-Cacher: A potential rover mission for 2018, Final report from the Mid-Range Rover Science Analysis Group (MRR-SAG), 94 pp., posted November 10, 2009, by the Mars Exploration Program Analysis Group (MEPAG) at: http://mepag.jpl.nasa.gov/reports/

20. Taylor, G J. and the rest of the Lunar Exploration Analysis Group SASS-SAT (2005). Rapid Response Report: LEAG Science Activities and Site Selection Specific Action Team (SASS-SAT). Unpublished white paper, commissioned by the NASA Chief Scientist.

21. Jakosky, B, Anbar, A. D., Taylor, G. J. and Lucey, P. (2004). Astrobiology Science Goals and Lunar Exploration. Unpublished white paper, 12 p, posted July, 2004 by the NASA Astrobiology Institute (NAI) at http://nai.arc.nasa.gov/institute/lunar_astrobiology.cfm

22. Shearer, C., Beaty, D.W., Anbar, A.D., Banerdt, B., Bogard, D., Campbell, B.A., Duke, M., Gaddis, L., Jolliff, B., Lentz, R.C.F., McKay, D., Neumann, G., Papanastassiou, D., Phillips, R., Plescia, J., and Wadhwa, M. (2004). Findings of the Moon-Mars Science Linkage Science Steering Group. Unpublished white paper, 29 p, posted October, 2004 by the Mars Exploration Program Analysis Group (MEPAG) at: http://mepag.jpl.nasa.gov/reports/index.html

23. Anbar, A. D., Buick, R., Meadows, V., Runnegar, B. (2004). Exploring Earth's past as a guide in the search for habitable worlds. NASA Astrobiology Institute White Paper in response to the Nov. 3, 2004, call for input from the NASA Science Mission Directorate.

24. Jakosky, B., Anbar, A. D., des Marais, D., Hoehler, T., D'Hondt, S., Onstott, T. (2004). Subsurface Life on the Earth and Planets. NASA Astrobiology Institute White Paper in response to the Nov. 3, 2004, call for input from the NASA Science Mission Directorate.

25. Anbar, A. D. (2002). Isotopes of iron: biomarker prospects. In: Signs of Life: A Report Based on the April 2000 Workshop on Life Detection Techniques, organized by the Committee on the Origins and Evolution of Life of the Board of Life Sciences and the Space Studies Board.

Patents and Invention Disclosures:

1. T. Steimle, A. D. Anbar, and J. L. Skulan. *System and Method for Isotopic Analysis of Calcium Using Laser Induced Fluorescence.* U.S. Patent No. 10,302,565, issued 5/28/2019.

2. A. D. Anbar, J. L. Skulan, G. Gordon, and J. Morgan. *Isotopic Biomarkers for Rapid Assessment of Bone Mineral Balance in Biomedical Applications.* U.S. Patent No. 9,261,519, issued 2/16/2016.

3. A. D. Anbar, J. L. Skulan, G. Gordon, and R. Fonseca. *Application of Ca Isotope Analysis to the Early Detection of Metastatic Cancer.* Non-provisional patent application 3/12/2014.

Published Abstracts (updated through Fall, 2024):

1. [#]M. Brunkhorst, M. Narish, J. L. Swann, C. Mead, D. Hunsley, and A. D. Anbar (2024). Milanko-What-Now? Designing a digital lesson to demystify Earth's climate cycles. *AGU Fall Meeting 2024.*

2. D. N. Huntzinger, C. Mead, G. Bruce, K. M. Schaefer, M. C. Mack, W. Taylor, L. Thompson, R. Logan, V. O. Leshyk, and A. D. Anbar (2024). Polar Explorer: A place-based virtual learning environment to improve STEM undergraduate education. *AGU Fall Meeting 2024.*

3. [#]B. Hasty, D. Hunsley, B. Teece, G. Bruce, C. Mead, and A. D. Anbar (2024). Designing digital education outreach for astrobiology: you are not alone. *AGU Fall Meeting 2024.*

4. [#]J. L. Swann, M. Narish, S. Kirk, A. Joseph Tamer, A. D. Anbar, and C. Mead (2024). Modular training in different modalities may increase use of digital learning tools by educators. *AGU Fall Meeting 2024.*

5. [*]C. Tremblay, C. Mead, M. N. Simon, and A. D. Anbar (2024). Validation of a novel scientific reasoning assessment instrument for theory revision abilities. *AGU Fall Meeting 2024.*

6. W. A. Hasley-Velez, G. J. Gilleaudeau, T. Gan, G-J. Reichart, R. Hennekam, M. N. Remirez, A. J. Kaufman, and A. D. Anbar (2024). Uranium isotope response to changing oxygen minimum zone dynamics in the Arabian Sea over the past 65 kyr. *2024 Goldschmidt Conference*.

7. A. D. Anbar and D. Weis (2024). Treatise of Geochemistry, 3rd Edition: How, why, where, when, and with whom? *2024 Goldschmidt Conference*.

8. [#]K. Rico, E. Swanner, and A. D. Anbar (2024). Examining the molybdenum paleo-redox proxy in modern ferruginous waters. *2024 Goldschmidt Conference*.

9. D. A. Williams, M. Narish, and A. D. Anbar (2024). Holey Tour planetary geology field trip: recent changes for an evolving planetary community. *2024 Lunar and Planetary Science Conference.*

10. A. D. Anbar, B. Teece, D. Hunsley, J. L. Swann, and G. Bruce (2024). Designing digital education outreach for astrobiology: you are not alone. *2024 Astrobiology Science Conference.*

11. [*]E. Edmans and A. D. Anbar (2024). Inhibition of molybdenum adsorption to manganese oxides by dissolved silica. *2024 Astrobiology Science Conference.*

12. [#]K. Rico, E. Swanner, and A. D. Anbar (2024). Molybdenum abundance and isotopes in ferruginous waters. *2024 Astrobiology Science Conference.*

13. [*]C. Tremblay, C. Mead, M. N. Simon, and A. D. Anbar (2024). Quantifying theory revision as a part of the scientific reasoning process. *2024 Astrobiology Science Conference.*

14. #A. J. J. Tamer, K. Steward, E. Macalalad, K. B. Tanaka, K. Barcase, T. Kaui, G. Bruce, D. Hunsley, and A. D. Anbar (2023). The value of training Hawaiian educators to create their own ESS virtual tours. *AGU Fall Meeting 2023.*

15. T.B. Oehmke, M. Rollins, A. J. J. Tamer, G. Bruce, and A. D. Anbar (2023). In the flow: an immersive experience illustrating how fluid dynamics connects us globally and impacts our climate. *AGU Fall Meeting 2023.*

16. C. Mead, P. LePore, J. P. Collins, A. D. Anbar, and S. Brownell (2023). Which undergraduates stay or leave the natural sciences: An investigation of differences for online and in person programs. *AGU Fall Meeting 2023.*

17. *C. Tremblay, C. Mead, M. N. Simon, and A. D. Anbar (2023). Quantifying theory revision capabilities as a part of the scientific reasoning process. *AGU Fall Meeting 2023*.

18. D. N. Huntzinger, C. Mead, G. Bruce, K. M. Schaefer, M. C. Mack, W. Taylor, L. Thompson, V. O. Leshyk, and A. D. Anbar (2023). Polar Explorer: A place-based virtual learning environment for STEM undergraduate education. *AGU Fall Meeting 2023*.

19. A. D. Anbar, J. L. Swann, S. Kirk, D. Hunsley, and N. Bier (2023). Improving and Expanding Access to Digital Learning through Open Source Adaptive Authoring. *AGU Fall Meeting 2023*.

20. #G. Bruce, J. L. Swann, S. Kirk, M. Narish, D. Hunsley, A. J. J. Tamer, T. Rauscher, C. Stummer, C. Mead, and A. D. Anbar (2023). Tour It: Empowering educators with a new user-friendly storytelling medium to create their own virtual field trips. *AGU Fall Meeting 2023*.

21. #M. Brunkhorst, M. Narish, C. Andert, D. Hunsley, S. Sackey, J. L. Swann, C. Mead, A. J. J. Tamer, and A. D. Anbar (2023). Integrating Chemistry and Earth Science: Teaching Ocean Acidification Using NASA Data. *AGU Fall Meeting 2023*.

22. #Rico, K., Swanner, E., and Anbar, A. D. (2023). Metals and Microbes and Redox, Oh My: Molybdenum Abundance and Isotopes in a Ferruginous Precambrian Analogue. *Geological Society of America Abstracts with Programs, 55* doi: 10.1130/abs/2023AM-395531

23. *E. Edmans and A. D. Anbar (2023). Inhibition of Molybdenum Adsorption to Manganese Oxides by Dissolved Silica: Implications for the Molybdenum Isotope Paleoredox Proxy. *2023 Goldschmidt Conference*.

24. *D. L. Sullivan, G. Brennecka, K. E. Grant, and A. D. Anbar (2023). Rhenium Isotope Reconnaissance of Uranium Ore Concentrates. *2023 Goldschmidt Conference*.

25. A. D. Anbar, R. Buick, G. Gordon, A. Johnson, B. Kendall, T. W. Lyons, C. M. Ostrander, N. J. Planavsky, C. T. Reinhard, and E. E. Stüeken (2023). Progressive Planetary Oxygenation: Multiple Lines of Evidence Confirm an Archean Oxidation Event at 2.5 Ga. *2023 Goldschmidt Conference*.

26. H. Hewitt, M. Simon, C. Mead, G. Haverstock, A. Anbar (2023). Bringing Exoplanet Research to the Online Astronomy Classroom. *American Astronomical Society Meeting Abstracts* 55, 246.01

27. K. Knierman, C. Groppi, T. Ashcraft, A. Coughlin, J. Bahamonde, J. Patience, N. Butler, P. Young, A. Van Engelen, A. Noble, M. Simon, J. Monkiewicz, J. Bowman, E. Shkolnik, K. Bossert, K. Whipple, A. Anbar, D. Hunsley, S. Sackey, and M. Bodin (2023). Second Year of Online Undergraduate Degree in Astronomical and Planetary Sciences. In *American Astronomical Society Meeting Abstracts* Vol. 55, 171-05.

28. A. D. Anbar (2022). Carl Sagan Lecture: The Science of Living Worlds. *AGU Fall Meeting 2022.* **Invited**

29. A. D. Anbar (2022). Making SciAct Smarter: Enhancing the Educational Effectiveness and Efficiency of NASA Digital Assets with Open Source Adaptive Technologies and Training. *AGU Fall Meeting 2022.*

30. A. D. Anbar, T. Lyons, R. Buick, B. Kendall, A. Johnson, C. Ostrander, E. Stüecken, C. Reinhardt and N. Planavsky (2022). Whither the Whiff? Reviewing and Reassessing Evidence of an Archean Oxidation Event at 2.5 Ga. *2022 Astrobiology Science Conference.*

31. *E. Edmans, C. Ostrander, A. Johnson and A. D. Anbar (2022). Extending Molybdenum Adsorption Experiments to Simulated Archean Seawater: the Effects of Silica Saturation. *2022 Astrobiology Science Conference.*

32. *B. Hasty, W. Zheng, D. L. Sullivan and A. Anbar (2022). Assessing the utility of Hg isotopes as evidence for atmospheric organic haze during the late Archean. *2022 Goldschmidt Conference.*

33. D. Huntzinger, C. J. Mead, L. Thompson, G. R. Bruce, A. D. Anbar, M. Mack, K. Schaeffer, V. O. Leshyk and W. Taylor (2022). Polar Explorer: An Interactive Virtual Field Trip-Based Exploration of Alaska and the Changing Arctic. *AGU Fall Meeting 2022.*

34. K. Knierman, C. Groppi, T. Ashcraft, A. Coughlin, J. Bahamonde, J. Patience, N. Butler, P. Young, A. Noble, A. Van Engelen, M. Simon, J. Monkiewicz, J. Bowman, E. Shkolnik, K. Whipple, A. Anbar, D. Hunsley, S. Sackey, M. Bodin, S. Miquirray, K. Ray and M. Loder (2022). First Year of Online Undergraduate Degree in Astronomical and Planetary Science. *American Astronomical Society Meeting Abstracts*, 54, Article 6.

35. #C. J. Mead, C. Price, A. D. Anbar, J. P. Collins, P. LePore and S. Brownell (2022). How are students with disabilities accommodated in a fully online degree program? *AGU Fall Meeting 2022.*

36. #M. Narish, S. Kirk, J. Swann, G. R. Bruce, D. Hunsley, C. J. Mead, A. D. Anbar, T. Rauscher and C. Stummer (2022). Tour It: Empowering educators with a new user-friendly storytelling medium to create their own virtual field trips. *AGU Fall Meeting 2022.*

37. *C. Ostrander, B. Kendall, G. W. Gordon, S. Nielsen, W. Zheng and A. D. Anbar (2022). Continuous shale heavy metal isotope records of low O_2 during the late-Archean. *2022 Astrobiology Science Conference.*

38. *D. L. Sullivan, W. Zheng, B. Hasty and A. Anbar (2022). Examining Mercury Abundance and Isotopic Fractionation During Chemical Weathering of Organic-Rich Shales. *2022 Goldschmidt Conference.*

39. #J. Swann, L. Manfredi, S. Sackey, M. Brunkhorst, D. Hunsley, C. J. Mead and A. D. Anbar (2022). Fate of the Plates: A virtual exploration of the dynamics of Earth's interior and plate tectonics. *AGU Fall Meeting 2022.*

40. #A. J. Tamer, K. Barcase, G. R. Bruce, M. Narish, C. J. Mead and A. D. Anbar (2022). Learning From the Co-development of Earth and Space Science Place-based, Immersive Experiences with Native Hawaiian Educators. *AGU Fall Meeting 2022.*

41. M. Wadhwa, A. D. Anbar, A. Tamer, S. M. Hanlon, O. Ambrogio, A. J. Shaner, C. B. Shupla, P. V. Graff and M. S. Kirk (2022). Reaching Diverse Audiences in Your Science Communications. *AGU Fall Meeting 2022.*

42. A. D. Anbar (2021). Catalyzing Collaborative Communities: the ABCs. *Goldschmidt 2021*. **Invited**

43. A. D. Anbar, P. Mishra and T. Davis (2021). ASU: The Future of STEM Education-A Conversation with Ariel Anbar and Punya Mishra. *AAAS 2021 Annual Meeting.*

44. A. D. Anbar, J. L. Swann, C. Mead and A. Tamer (2021). Transforming Earth and Space Science Education. *AGU Fall Meeting 2021*.

45. B. Scragg, T. Davis, M. Norton, P. Mishra and A. Anbar (2021). Designing the future of undergraduate STEM education: An inter-institutional and interdisciplinary approach. *Society for Information Technology and Teacher Education International Conference*.

46. L. Spilker, M. Cable, C. Porco, C. Glein, J. Lunine, C. Phillips, C. German, S. MacKenzie, M. Neveu, T. Hoehler, A. E. Hofmann, A. Hendrix, J. Eigenbrode, F. Postberg, A. McEwen, N. Khawaja, J. Waite, P. Wurz, J. Helbert, A. Anbar, J-P. de Vera and J. Nunez (2021). The Science Case for a Return to Enceladus. *AGU Fall Meeting 2021*.

47. *D. L. Sullivan, S. Romaniello, W. Zheng and A. D. Anbar (2021). Reconstructing Redox with Rhenium: Advances in Characterizing Authigenic δ^{187}Re in Carbonaceous Sediments and Shales. *AGU Fall Meeting 2021*.

48. #A. J. Tamer, G. Bruce, M. Narish, B. R. Smith-Konter, A. Anderson, S. K. Rowland, N. Gomes and A. D. Anbar (2021). Indigenous Voices Provide Context in Kīlauea Virtual Tours. *AGU Fall Meeting 2021*.

49. *L. A. Tegler, S. G. Nielsen, C. M. Ostrander, A. Anbar, B. Kendall, J. Owens, L. Peterson, F. Scholz and T. J. Horner (2021). Redox and productivity controls on the cadmium isotope composition of organic-rich sediments. *Goldschmidt 2021*.

50. M. Wadhwa, D. A. Williams, J. L. Swann, A. D. Anbar, C. J. Mead, A. J. Tamer, J. F. Bell, G. P. Asner, K. Bossert and E. L. Shkolnik (2021). The NASA SMD Community of Practice for

Education (SCoPE): A New Science Activation Program Integration Project to Connect SMEs with NASA SCIACT. *Lunar and Planetary Science Conference*, Article 2548.

51. A. Zhou, M. Nolan, S. Sahoo, C. M. Ostrander, A. Anbar, D. Jones, S. Xiao, J. Chen and W. Zheng (2021). Recurrent photic zone euxinia in Ediacaran South China Basin revealed by mercury enrichment and isotope compositions. *Goldschmidt 2021*.

52. A. D. Anbar, M. Feldstein, D. Schönstein and T. Calvert (2020). edOS: catalyzing an ecosystem of advanced courseware creation. Abstract ED013-07 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

53. A. D. Anbar, C. M. Ostrander, A. Johnson and D. C. Catling (2020). Redox Revolutions on Earth and Beyond: Implications for Life Detection on Extrasolar Worlds. Abstract P024-0008 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

54. D. Bratton, A. D. Anbar, M. Renfrey, J. L. Swann, C. Mead, M. Bodin (2020). Using an Interactive, 3D Visualization to Teach Phases of the Moon. Abstract ED012-04 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

55. G. Bruce, C. Mead, W. Taylor and A. D. Anbar (2020). Gamifying virtual exploration of the past 350 million years of vertebrate evolution. Abstract ED006-11 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

56. S. Kadoya, D. C. Catling, R. W. Nicklas, I. S. Puchtel and A. D. Anbar (2020). Secular oxidation of the mantle decreased the proportion of reducing gases in volcanic emissions and could trigger the atmospheric oxygenation. Abstract DI022-06 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

57. *C. M. Ostrander, T. W. Lyons, B. Kendall, S. Severmann, S. J. Romaniello, W. Zheng and A. D. Anbar (2020). New Fe isotope insights into the oxidation history of a Neoarchean Earth. Abstract V032-0005 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

58. *T. J. Ruberto, C. Mead, R. Aggarwal, G. Bruce, S. Semken, A. J. Tamer and A. D. Anbar (2020). Democratizing Virtual Field Trips: Teaching Learners to Create Their Own Virtual Field Trips for Earth and Space Science and Sustainability. Abstract ED006-10 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

59. S. Semken, C. J. Mead, T. J. Ruberto, G. R. Bruce, R. M. Aggarwal, & A. D. Anbar (2020). Stakeholder-produced virtual field experiences can contribute to geoheritage. *GSA Annual Meeting*. https://doi.org/10.1130/abs/2020AM-358426

60. J. Swann, S. Kirk, C. Mead and A. D. Anbar (2020). Teacher Professional Development to Support Transition to Online. Abstract ED013-06 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

61. *P. Vergeli, S. J. Romaniello, H. E. Hartnett, W. Zheng and A. D. Anbar (2020). Assessing the Importance of Iron Photo-oxidation on Ancient Earth and Beyond. Abstract EP059-03 presented at the *2020 Fall Meeting, AGU, Online*, 1-17 Dec.

62. A. D. Anbar (2020). Redox Revolutions: Earth and Beyond. Abstract U11-02 presented at the *2020 JpGU-AGU Joint Meeting, Online*, 12-16 July.

63. S. Kadoya, D. C. Catling, R. W. Nicklas, I. S. Puchtel and A. D. Anbar (2020). Mantle data imply that secular oxidation can drive oxygenation of the atmosphere. Abstract BCG06-05 presented at the *2020 JpGU-AGU Joint Meeting, Online,* 12-16 July. **Invited**.

64. A. D. Anbar (2020). Applications of Non-Traditional Isotopes to Environmental and Human Health – A 2040 Perspective. *Goldschmidt 2020*, https://doi.org/10.46427/gold2020.58

65. L. A. Tegler, C. M. Ostrander, A. D. Anbar, B. Kendall, S. G. Nielsen and T. J. Horner (2020). Minimal Cadmium-Isotopic Variations during a 'whiff' of O_2 at 2.5 Ga. *Goldschmidt 2020*, https://doi.org/10.46427/gold2020.2577

66. S. T. Rader, R. M. Gaschnig, G. E. Bebout, S. J. Romaniello, C. M. Ostrander and A. D. Anbar (2020). *Goldschmidt 2020*, https://doi.org/10.46427/gold2020.2149

67. *P. Vergeli, S. J. Romaniello, H. E. Hartnett, and A. D. Anbar (2020). *Goldschmidt 2020*, https://doi.org/10.46427/gold2020.2675

68. A. D. Anbar, A. J. Tamer and J. L. Swann (2020). Infiniscope: Connecting Authentic NASA Science with K12 Educators Through a Digital Teaching Network. *51st Lunar and Planetary Science Conference*, held 16-20 March, 2020 at The Woodlands, Texas. LPI Contribution No. 2326, 2020, id.2819.

69. A. D. Anbar, S. Kadoya, R. W. Nicklas, I.S. Puchtel, D.C. Catling (2019). The Great Oxidation Event: An Inside Job? Abstract MR51A-08 presented at the *2019 Fall Meeting, AGU*, San Francisco, CA, 9-13 Dec. **Invited**.

70. A. D. Anbar and H. E. Hartnett (2019). Biogeosciences beyond: Inventing a science of living worlds. Abstract B14B-01 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec. **Invited**.

71. H. E. Hartnett, N. R. Hinkel, A. D. Anbar, S. J. Desch, T. Fisher, H. Furukawa, D. Glaser, J. G. Okie, C. T. Unterborn, P. Vergeli, S. Walker, and P. Young (2019). The biogeosciences are a critical step on the path toward detecting life on exoplanets. Abstract B13C-11 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

72. #J. L. Swann, C. Mead, and A. D. Anbar (2019). Consumers to creators: Reducing the barrier of entry for educators to customize digital learning experiences. Abstract ED11B-0863 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

73. #D. Bratton, M. Renfrey, K. Fogelson, C. Mead, and A. D. Anbar (2019). Combining Eyes on the Solar System, a rich narrative, and adaptive feedback to teach Solar and Lunar eclipses. Abstract ED11B-0871 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

74. #C. Mead and A. D. Anbar (2019). Using computer learning analytics to support learning design, evaluation, and teaching. Abstract ED12A-02 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

75. #G. Bruce, W. Taylor, C. Mead, S. Buxner, S. Semken, and A. D. Anbar (2019). Gamifying Virtual Exploration of the Past 350 Million Years of Vertebrate Evolution. Abstract ED22A-01 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

76. #A. J. Tamer, T. Ruberto, C. Mead, G. Bruce, S. Semken, A. D. Anbar, and R. Aggarwal (2019). Teaching and learning about Earth science and sustainability with student-created virtual field trips. Abstract ED22A-06 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

77. #C. Mead, S. Brownell, J. P. Collins, P. LePore, and A. D. Anbar (2019). Using Institutional Analysis of Grades to Assess Equity of Outcomes in Online and In-Person Science Courses. Abstract ED31C-0977 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

78. *C. M. Ostrander, J. D. Owens, S. Nielson, and A. D. Anbar (2019). Tracking the accumulation of O_2 in Archean oceans using thallium and molybdenum isotopes. Abstract V23B-01 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

79. *A. Johnson, A. T. Greaney, M. Toc, R. L. Rudnick, J. Foden, and A. D. Anbar (2019). Molybdenum Isotope Fractionation in Arc Settings: Implications for the Distribution of Mo in the Continental Crust. Abstract V54A-06 presented at the 2019 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.

80. J. Kang, S. Xiao, F. Zhang, and A. D. Anbar (2019). Life in oxygen oases during the terminal ediacaran expansion of marine anoxia. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-335995.

81. *C. M. Ostrander, S. K. Sahoo, B. Kendall, G. Jiang, N. J. Planavsky, T. W. Lyons, S. G. Nielsen, J. D. Owens, S. J. Romaniello, and A. D. Anbar (2019). Multiple negative molybdenum isotope excursions in the Doushantuo Formation (South China) fingerprint complex redox-related processes in the Ediacaran Nanhua Basin. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-341144.

82. #G. Bruce, C. Oliver, W. L. Taylor, C. Mead, S. Semken, R. E. Summons, S. Buxner, and A. D. Anbar (2019). Advancing 25 years of digital innovation - exploring the evolution of 360° virtual field trips from apple's human interface group to modern gamification and beyond. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-336907

83. *L. Tegler, C. M. Ostrander, A. D. Anbar, S. G. Nielsen, and T. J. Horner (2019). Exploring cadmium as a proxy for primary productivity before the great oxidation event. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-338476

84. #G. Gilleaudeau, S. K. Sahoo, J. D. Owns, S. W. Poulton, T. W. Lyons, and A. D. Anbar (2019). Molybdenum isotope and trace metal signals in an iron-rich Mesoproterozoic ocean: a

snapshot from the Vindhyan Basin, India. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-339003

85. *T. Ruberto, S. Semken, C. Mead, G. Bruce, S. Buxner, and A. D. Anbar (2019). Mixed-methods research on the implications of learning outcomes for in-situ and virtual geological field trips. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-340703.

86. #G. Bruce, W. Taylor, C. Mead, S. Buxner, and A. D. Anbar (2019). Digital innovations in gamification, adaptivity, and rich learning design to virtually explore the past 350 million years. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-336856.

87. *A. C. Johnson, S. J. Romaniello, C. M. Ostrander, C. T. Reinhard, T. W. Lyons, and A. D. Anbar (2019). Assessing the bioavailability of Mo in Archean oceans. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-341070

88. *D. Sullivan, S. J. Romaniello, and A. D. Anbar (2019). Exploring the potential of the Re isotope paleoredox proxy. Geological Society of America Abstracts with Programs. Vol. 51, No. 5, doi: 10.1130/abs/2019AM-340982.

89. A. D. Anbar (2019). The Mission to Early Earth: The 20-year Legacy of NASA's First Astrobiology Sample Return. Astrobiology Science Conference, Seattle, WA, June 24 – 28. **Invited**.

90. *C. M. Ostrander, S. Nielsen, J. D. Owends, B. Kendall, G. W. Gordon, S. J. Romaniello, and A. D. Anbar (2019). Fully oxygenated water columns over continental shelves before the Great Oxidation Event. Astrobiology Science Conference, Seattle, WA, June 24 – 28. **Invited**.

91. #L. Horodyski, C. Mead, C. Oliver, and A. D. Anbar (2018). Teaching Real Science: A Novel Approach to Teaching Students the Scientific Process. Astrobiology Science Conference, Seattle, WA, June 24 – 28.

92. *D. L. Sullivan, S. J. Romaniello, and A. D. Anbar (2019). Developing Rhenium Isotopes as a Paleoredox Proxy. Goldschmidt2019 18-23 August, Barcelona, Spain.

93. A. D. Anbar (2019). Isotope Paleoredox Proxies: From Inspiration to Innovation – Samuel Epstein Science Innovation Award Lecture. Goldschmidt2019 18-23 August, Barcelona, Spain. **Invited**.

94. A. D. Anbar (2019). The Planet as Province. Goldschmidt2019 18-23 August, Barcelona, Spain. **Invited**.

95. *C. Ostrander and A. D. Anbar (2019). New Insights after a Good Long Sniff of the "Whiff". Goldschmidt2019 18-23 August, Barcelona, Spain.

96. #S. J. Romaniello, G. W. Gordon, J. Skulan, S. M. Smith, S. R. Zwart, and A. D. Anbar (2019). Evaluating Spaceflight-Induced Bone Loss in Astronauts Using Ca Isotopes. Goldschmidt2019 18-23 August, Barcelona, Spain.

97. *A. Johnson, S. Aarons, N. Dauphas, N. Nie, H. Zeng, F. Teng, R. Helz, G. Galli, S. J. Romaniello, and A. D. Anbar (2019). Titanium Isotope Fractionation in Kilauea Iki Lava Lake is Driven by the Crystallization of Oxides. Goldschmidt2019 18-23 August, Barcelona, Spain.

98. *F. Zhang, S. Xiao, T. Dahl, N. Planavsky, S. J. Romaniello, T. Lenton, and A. D. Anbar (2019). Extensive Marine Anoxia during the Tonian Period Revealed by Uranium Isotopes in Marine Carbonates. Goldschmidt2019 18-23 August, Barcelona, Spain.

99. #G. Gilleaudeau, T. Algeo, T. Lyons, S. Bates, and A. D. Anbar (2019). Redox Gradients in the Early Mississippian Appalachian Basin: Evidence from Iron Speciation and Trace Metal Abundances. Goldschmidt2019 18-23 August, Barcelona, Spain.

100. A. D. Anbar (2019). Avoiding "false negatives" in the search for life on other worlds: Lessons from ancient Earth. ACS Annual Meeting and Expo, 28 March – 4 April, Orlando, Florida.

101. A. D. Anbar, L. Manfredi, D. Bratton, and A. J. Tamer (2018). Adapting 3D visualizations to meet the needs of educators in Earth and space sciences. Abstract ED32A-06 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

102. *X. Chen, S. J. Romaniello, A. D. Herrmann, E. Samankassou, and A. D. Anbar (2018). Biological effects on uranium isotope fractionation in primary biogenic carbonates. Abstract PP44A-02 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

103. #L. Horodyskyj, G. Bruce, S. Semken, A. D. Anbar, and L. Hosman (2018). Online geosciences offline. Abstract ED11C-0749 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

104. #L. Horodyskyj, C. Mead, Z. Pardos, and A. D. Anbar (2018). Improving student outcomes through informed use of learning analytics. Abstract ED51G-0718 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

105. *A. Hyatt, A. J. Tamer, W. M. Oliver, S. D. Spears, and A. D. Anbar (2018). Student-produced digital media to address misconceptions for multiple online audiences with an adaptive learning platform. Abstract ED41E-1236 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

106. #C. Mead, H. B. Davis, J. L. Swann, and A. D. Anbar (2018). What kinds of digital learning experiences do educators want? Abstract ED31D-1084 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

107. #C. Mead, A. Landrum, D. Kahan, and A. D. Anbar (2018). Science curiosity can predict success in science courses. Abstract ED41E-1250 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

108. #S. J Romaniello, A. Johnson, C. M Ostrander, and A. D. Anbar (2018). How low can you Mo?: Reevaluating molybdenum limitation in Precambrian oceans. Abstract PP41D-1877 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

109. #J. L. Swann, C. Mead, D. Hunsley, and A. D. Anbar (2018). Training educators to build and modify adaptive digital learning experiences. Abstract ED41E-1249 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

110. N-T. Truong, C. R. Glein, A. Monroe, A. D. Anbar, and J. I. Lunine (2018). Decomposition of amino acids in water with application to Enceladus and other ocean worlds. Abstract P33A-08 presented at the 2018 Fall Meeting, AGU, Washington, DC, 10-14 Dec.

111. *A. C. Johnson, C. T. Reinhard, S. J. Romaniello, A. T. Greaney, D. D. Gregory, T. W. Lyons, and A. D. Anbar (2018). Constraints on Earth's stepwise oxygenation from sulfide oxidation experiments at low pO_2. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

112. *F. Zhang, K. Lau, S. Romaniello, S. Xiao, and A. Anbar (2018). Calcium isotope constraints on the terminal Ediacaran rise of calcified animals. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

113. Z. Li, F. Zhang, S. Romaniello, L. Zhao, and A. Anbar (2018). Climate change and U isotope excursion during Carnin Event in South China. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

114. ¶A. T. Greaney, R. L. Rudnick, S. J. Romaniello, and A. D. Anbar (2018). Completing the molybdenum isotope mass balance in subduction zones. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

115. #S. J. Romaniello, X. Chen, F. Zhang, T. J. Algeo, and A. D. Anbar (2018). Diagenesis is not a dirty word. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

116. *X. Chen, S. Romaniello, M. McCormick, A. Sherry, J. Havig, and A. Anbar (2018). Do manganese oxides dominate transport of Mo across the chemocline of redox-stratified lakes? 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

117. H. Hartnett, C. Till, A. Anbar, D. Glaser, M. Guild, K. Iacovino, A. Johnson, J. Leong, and C. Ostrander (2018). Solid-Earth processes are key drivers in the evolution of Earth's redox state and set the stage for the Great Oxidation Event. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

118. H. Zhao, F. Zhang, T. Algeo, S. Romaniello, and A. Anbar (2018). Uranium isotope variation across the Smithian-Spathian Boundary. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

119. #W. Zheng, R. E. Summons, and A. D. Anbar (2018). Mercury isotopes as a novel proxy of photic zone euxinia. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

120. *C. Ostrander, S. Nielsen, J. Owens, B. Kendall, G. Gordon, S. Romaniello, and A. Anbar (2018). Oxygen oases were persistent and widespread before the GOE. 28th V. M. Goldschmidt Conference, 12-17 August, Boston, MA.

121. A. D. Anbar (2018). Educating through exploration: emerging evidence for improved learning outcomes using a new theory of digital learning design. Abstract presented at the 231st Meeting of the American Astronomical Society, Washington, DC, 8-12 Jan. **Invited**.

122. A. D. Anbar, C. Mead, D. Bratton, L. Horodyskyj, J. Hayes, D. Schonstein, S. Watt, K. Watt, D. Ben-Naim, A. Leon (2017). Demonstrating the Value of Education Through Exploration as a Theory of Digital Design. Abstract ED41B-0275 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

123. #G. J. Gilleaudeau, A. J. Kaufman, G. Luo, S. J. Romaniello, F. Zhang, L. Kah, K. Azmy, J. K. Bartley, S. K. Sahoo, A. H. Knoll, and A. D. Anbar (2017). Constraining the redox landscape of the mid-Proterozoic oceans: new insights from the carbonate uranium isotope record. Abstract PP43E-07 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

124. ¶A. T. Greaney, R. L. Rudnick, S. J. Romaniello, A. Johnson, R. M. Gaschnig, and A. D. Anbar (2017). Molybdenum isotopes reveal oxidation of Earth's continental crust during the 2.4 Ga Great Oxidation Event. Abstract V24C-02 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

125. #L. Horodyskyj, C. Mead, and A. D. Anbar (2017). Finding actionable data to support student success in introductory science courses. Abstract ED31E-01 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec. **Invited**.

126. #L. Horodyskyj, T. Lennon, C. Mead, and A. D. Anbar (2017). Build a Catastrophe: Using Digital World and Policy Models to Engage Political Science Students with Climate Change. Abstract ED31A-0270 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

127. J. R. McDaris, T. J. Bralower, A. D. Anbar, and A. Leinbach (2017). Teaching about the Earth Online: Faculty-Sourced Guidance from InTeGrate. Abstract ED53E-0197 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

128. S. Semken, T. Ruberto, C. Mead, G. Bruce, S. Buxner, and A. D. Anbar (2017). Learning outcomes of in-person and virtual field-based geoscience instruction at Grand Canyon National Park: complementary mixed-methods analyses. Abstract ED31E-03 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

129. *A. M. Sherry, S. J. Romaniello, P. Herckes, and A. D. Anbar (2017). Experimental Constraints on Iron Mobilization into Biomass Burning Aerosols. Abstract A31C-2179 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

130. #A. J. Tamer, A. D. Anbar, L. T. Elkins-Tanton, S. Klug Boonstra, C. Mead, J. L. Swann, and D. Hunsley (2017). Building effective learning experiences around visualizations: NASA Eyes on the Solar System and Infiniscope. Abstract ED14A-04 presented at the 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

131. A. Anbar (2017) Designing an integrated theory of Earth system oxygenation. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-302163. **Invited**.

132. A. D. Anbar, C. Bentley, and S. Semken (2017). Proposing a digital teaching network for virtual field experiences. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-308015.

133. #G. Gilleaudeau, C. K. Junium, L. C. Kah, N. Zolotova, and A. D. Anbar (2017). No evidence for alternative nitrogenase expression in a Mesoproterozoic molybdenum-limited environment: constraints from nitrogen isotopes at 1.1 Ga. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-306732.

134. *A. C. Johnson, C. T. Reinhard S. J. Romaniello, A. T. Greaney, E. Garcia-Robledo, N. P. Revsbech, D. Canfield, T, W. Lyons, and A. D. Anbar (2017). Quantifying Archean oxygenation - insights from sulfide oxidation experiments at low pO_2. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-306329.

135. *C. M. Ostrander, B. Kendall, S. J. Romaniello, G. W. Gordon, S. Olson, T. W. Lyons, S. G. Nielsen, W. Zheng, and A. D. Anbar (2017). Constraining the molybdenum isotope budget of 2.63 – 2.50 Ga oceans. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-306885.

136. T. Ruberto, C. Mead, S. Semken, G. Bruce, S. Buxner, and A. D. Anbar (2017). Contrasting, complementary learning outcomes of in-person and virtual field-based geoscience instruction at Grand Canyon National Park. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-306229.

137. *F. Zhang, T. J. Algeo, S. Romaniello, and A. D. Anbar (2017). Quantitative constraints on End-Permian and Early Triassic oceanic anoxia using high-resolution $\delta^{238}U$ records. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-303720.

138. #W. Zheng, G. J. Gilleaudeau, L. C. Kah, and A. D. Anbar (2017). Mercury stable isotopes as a novel proxy for photic zone euxinia. Geological Society of America Abstracts with Programs. Vol. 49, No. 6 doi: 10.1130/abs/2017AM-307848.

139. A. Anbar (2017) Designing an integrated theory of Earth's biogeochemical evolution. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France. **Honorary – Endowed Biogeochemistry Lecture.**

140. A. Anbar, C. Mead, V. Peters, L. Horodyskyj, and D. Ben-Naim (2017). Transforming STEM education through digital teaching networks. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

141. ¶M. Cheng, C. Li, F. Zhang, and A. Anbar (2017). Constrain the global redox state of post-Marinoan Ocean with paired Mo-U isotopes. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

142. #G. Gilleaudeau, R. Frei, A. Kaufman, G. Luo, S. Romaniello, F. Zhang, R. Klaebe, S. Sahoo, L. Kah, K. Azmy, J. Bartley, P. Chernyavskiy, A. Knoll, and A. Anbar (2017). Deciphering the carbonate record of Mesoproterozoic biospheric oxygenation: insights from chromium and uranium isotopes. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France. **Invited.**

143. #L. Horodyskyj, G. Bruce, L. McAllister, S. Semken, A. Anbar, and L. Hosman (2017). Online geoscience offline. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

144. *A. C. Johnson, C. T. Reinhard S. J. Romaniello, E. Garcia-Robledo, N. P. Revsbech, D. Canfield, T, W. Lyons, and A. D. Anbar (2017). Archean oxidative weathering: insights from sulfide oxidation experiments at ultra-low pO_2. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

145. *C. Ostrander, B. Kendall, S. Romaniello, G. Gordon, and A. Anbar (2017). Mo isotope evidence for a global expansion in marine euxinia ~ 2.5 billion years ago. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

146. #S. J. Romaniello, F. Zhang, T. J. Algeo, and A. D. Anbar (2017). Constraining drivers of the End-Permian Mass Extinction using high-resolution records of marine anoxia. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

147. *F. Zhang, S. Romaniello, B. Kendall, S. Xiao, and A. Anbar (2017). Global marine redox changes drove the rise and fall of the early animals. 27th V. M. Goldschmidt Conference, 13-18 August, Paris, France.

148. A. Anbar, D. Ben-Naim, and C. Mead (2017). Digital Teaching Networks Inspired by Astrobiology: Adaptive Scaling of High-Quality Learning Resources. Abstract 3641 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

149. D. D. Bratton III, J. Hayes, D. Sarno, G. Bruce, L. Horodyskyj, C. Mead, D. Ben-Naim, and A. D. Anbar (2017). Bringing active field-based learning to scale in astrobiology: virtual field trips and adaptive courseware. Abstract 3662 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

150. *P. R. Castleberry, S. J. Romaniello, and A. D. Anbar (2017). The Possible Photochemical Origins of Banded Iron Formations. Abstract 3528 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

151. *X. Chen, A. Sherry, S. J. Romaniello, J. Havig, M. McCormick, and A. D. Anbar (2017). Exploring molybdenum and uranium isotope fractionation across the chemocline of Fayetteville Green Lake, New York. Abstract 3603 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

152. #L. B. Horodyskyj, C. Mead, and A. D. Anbar (2017). Teaching assumptions: the missing component of the scientific process. Abstract 3500 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

153. *A. C. Johnson, C. T. Reinhard, S. J. Romaniello, A. Greaney, E. Garcia-Robledo, N. P. Revsbech, D. E. Canfield, T. W. Lyons, and A. D. Anbar (2017). Reconciling "whiffs" of O_2 with the Archean MIF S record: insights from sulfide oxidation experiments. Abstract 3584 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

154. #C. Mead, L. Horodyskyj, S. Buxner, S. Semken, and A. Anbar (2017). Advances in assessments of astrobiology learning outcomes and data-driven student support. Abstract 3625 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

155. #A. A. Monroe, C. R. Glein, A. D. Anbar, E. L. Shock, and J. L. Lunine (2017). Amino acid destruction considerations for in situ measurements of Enceladus and other ocean worlds. Abstract 3319 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

156. M. Neveu, A. D. Anbar, J. Baross, D. P. Glavin, C. P. McKay, C. C. Porco, B. Sherwood, Y. Takano, and H. Yano (2017). Quantitative planetary protection for sample return from ocean worlds. Abstract 3008 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

157. *C. M. Ostrander, B. Kendall, G. W. Gordon, S. J. Romaniello, and A. D. Anbar (2017). The "whiff" of oxygen 2.5 billion years ago: global or local? Abstract 3709 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

158. *V. Perera, C. Mead, S. Buxner, L. Horodyskyj, S. Semken, D. Lopatto, and A. D. Anbar (2017). Gauging students' attitudes towards science to improve science pedagogy. Abstract 3690 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

159. #S. J. Romaniello, F. Zhang, T. J. Algeo, and A. D. Anbar (2017). High-Resolution Reconstruction of Anoxia Across the End-Permian Mass Extinction from Composite Uranium Isotope Records. Abstract 3729 presented at the 2017 Astrobiology Science Conference, 24-28 April, Mesa, AZ.

160. A. D. Anbar, L. T. Elkins-Tanton, S. Klug Boonstra, and D. Ben-Naim (2016). The Exploration Connection. Abstract ED24A-05 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec. **Invited**.

161. A. D. Anbar, H. E. Hartnett, A. York, and C. Selin (2016). The Anthropocene: a planetary perspective. Abstract U13A-06 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec. **Invited**.

162. D. Bratton, C. Mead, L. Horodyskyj, and A. D. Anbar (2016). Development and evaluation of a fully-online introductory biology course with an emphasis on the possibility of life beyond Earth. Abstract ED43A-0848 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

163. #G. Bruce, C. Mead, S. Buxner, W. Taylor, S. C. Semken, A. D. Anbar, and J. Sundstrom (2016). Immersive, interactive virtual field trips promote learning. Abstract ED43A-0845 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

164. #G. Bruce, W. Taylor, A. D. Anbar, S. C. Semken, S. Buxner, C. Mead, E. El-Moujaber, R. E. Summons, and C. Oliver (2016). Linking immersive virtual field trips with an adaptive learning platform. Abstract ED51H-0848 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

165. *P. Castleberry, S. J. Romaniello, and A. D. Anbar (2016). What do we really know about the origins of banded iron formations? Abstract V13E-2900 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

166. *X. Chen, S. J. Romaniello, A. D. Herrmann, and A. D. Anbar (2016). Diagenetic effects on uranium isotope fractionation in carbonate sediments from the Bahamas. Abstract PP11B-2015 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

167. #G. W. Gordon, S. J. Romaniello, J. Skulan, A. D. Anbar, S. M. Smith, and S. Zwart (2016). Astronaut bones: stable calcium isotopes in urine as a biomarker of bone mineral balance. Abstract PA44B-05 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

168. K. Goto, J. R. Hein, G. Shimoda, S. Aoki, A. Ishikawa, K. Suzuki, G. W. Gordon, and A. D. Anbar (2016). Molybdenum isotopes in modern marine hydrothermal Fe/Mn deposits: implications for Archean and Paleoproterozoic Mo cycles. Abstract V13E-2895 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

169. #L. Horodyskyj, C. Mead, and A. D. Anbar (2016). I assumed you knew: teaching assumptions as co-equal to observations in scientific work. Abstract ED21A-0763 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

170. #L. Horodyskyj, C. Mead, S. Buxner, S. C. Semken, and A. D. Anbar (2016). Assessing complex learning objectives through analytics. Abstract ED41C-02 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

171. *A. Johnson, C. T. Reinhard, S. J. Romaniello, A. T. Greaney, E. Garcia-Robledo, N-P. Revsbech, D. E. Canfield, T. W. Lyons, and A. D. Anbar (2016). Reconciling "whiffs" of O_2 with the Archean MIF S record: insights from sulfide oxidation experiments. Abstract V13B-2836 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

172. #C. Mead, L. Horodyskyj, S. Buxner, S. C. Semken, and A. D. Anbar (2016). Different behavioral patterns of success for men and women in an online introductory science course: Addressing the course grade gender gap. Abstract ED41C-03 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

173. #C. Mead, L. Horodyskyj, S. Buxner, S. C. Semken, and A. D. Anbar (2016). Measuring scientific reasoning through behavioral analysis in a computer-based problem solving exercise. Abstract ED43A-0846 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

174. *V. Perera, C. Mead, S. Buxner, L. Horodyskyj, S. C. Semken, D. Lopatto, and A. D. Anbar (2016). Assessing student attitudes towards science in an adaptive online astrobiology Course: comparing online and on-campus undergraduates. Abstract ED43A-0847 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

175. *C. M. Ostrander, B. Kendall, M. Roy, S. J. Romaniello, S. J. Nunn, G. W. Gordon, S. L. Olson, T. W. Lyons, W. Zhang, and A. D. Anbar (2016). Re-assessing the molybdenum isotope composition of pre-GOE seawater: evidence for dynamic ocean redox. Abstract V54A-03 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

176. #S. J. Romaniello, C. M. Ostrander, A. Johnson, N. Planavsky, and A. D. Anbar (2016). What the flux? Deriving empirical estimates of riverine Mo fluxes over Earth history. Abstract V13B-2834 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

177. S. C. Semken, T. Ruberto, C. Mead, G. Bruce, S. Buxner, and A. D. Anbar (2016). Complementary research on student geoscience learning at Grand Canyon by means of in-situ and virtual modalities. Abstract ED43A-0844 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

178. ¶H. Song, H. Song, T. J. Algeo, S. J. Romaniello, J. Tong, Y. Du, H. Wei, S. Shen, and A. D. Anbar (2016). Uranium isotope evidence for the abrupt onset of oceanic anoxia during the end-Guadalupian mass extinction. Abstract V51A-3044 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

179. *L. A. Tegler, A. M. Sherry, S. J. Romaniello, and A. D. Anbar (2016). Forest fires as a possible source of isotopically light marine Fe aerosols. Abstract A31C-0040 presented at the 2016 Fall Meeting, AGU, San Francisco, CA, 12-16 Dec.

180. S. Semken, G. Bruce, C. Mead, S. Buxner,. W. L. Taylor, T. Ruberto, and A. D. Anbar (2016). Reinvigorating the traditional "historical geology" curriculum with immersive virtual field exploration of the history of Earth and life. Geological Society of America *Abstracts with Programs.* Vol. 48, No. 7 doi: 10.1130/abs/2016AM-285458

181. K. Goto, G. Shimoda, A. Anbar, G. Gordon, Y. Harigane, R. Senda, K. Suzucki, and J. Hein (2016). Molybdenum isotopes in marine hydrothermal Mn deposits. 26th V. M. Goldschmidt Conference, Yokohama, Japan, 26 June - 1 July.

182. *A. Johnson, C. T. Reinhard, S. J. Romaniello, E. Garcia-Robledo, N-P. Revsbech, D. E. Canfield, T. W. Lyons, and A. D. Anbar (2016). Mobilizing molybdenum: interpreting Archean oxidative weathering signatures. 26th V. M. Goldschmidt Conference, Yokohama, Japan, 26 June - 1 July.

183. #S. J. Romaniello, F. Zhang, T. Algeo, K. Lau, X. Chen, M. Elrick, A. Herrmann, and A. D. Anbar (2016). Validation of the carbonate $^{238}U/^{235}U$ paleoredox proxy: evidence from multiple localities spanning the Permian-Triassic Boundary. 26th V. M. Goldschmidt Conference, Yokohama, Japan, 26 June - 1 July. **Invited**.

184. S. Takahashi, G. W. Gordon, K. Ozaki, S-I. Yamasaki, K. Kimura, A. D. Anbar, R. Tada (2016). Variations of U and Mo isotopes across the deep sea Permian-Triassic Boundary. 26th V. M. Goldschmidt Conference, Yokohama, Japan, 26 June - 1 July.

185. *F. Zhang, C. Li, V. Melezhik, W. Shi, M. Cheng, B. Kendall, S. J. Romaniello, J. Owens, and A. Anbar (2016). Uranium isotope variation across the Ediacaran Shuram Excursion. V. M. Goldschmidt Conference, Yokohama, Japan, 26 June - 1 July.

186. A. D. Anbar and the Dynamics of Earth System Oxygenation Team (2015). Earth system oxygenation: toward an integrated theory of Earth evolution. Abstract U24A-08 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec. **Invited.**

187. A. D. Anbar and the ETX Center Research and Evaluation Team (2015). Education through exploration: evaluating the unknown. Abstract ED53A-843 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec. **Invited.**

188. *X. Chen, S. Romaniello, A. Herrmann, L. Wasylenki, and A. Anbar (2015). Uranium isotopes in calcium carbonate: a possible proxy for paleo-pH and carbonate ion concentration? Abstract PP33C-2334 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

189. A. Herrmann, T. Algeo, G. Gordon, and A. Anbar (2015). Uranium isotopes as a potential global-ocean redox proxy: a test from the Upper Pennsylvanian Hushpuckney Shale (Kansas, U.S.A.). Abstract PP31B-2250 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

190. #L. Horodyskyj, C. Mead, S. Buxner, S. Semken, and A. Anbar (2015). Data-driven design: learning from student experiences and behaviors. Abstract ED52A-0844 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

191. *A. Johnson, S. Romaniello, C. Reinhard, E. Garcia-Robledo, N-P. Revsbech, D. Canfield, T. Lyons, and A. Anbar (2015). Oxidative weathering of Archean sulfides: implications for the Great Oxidation Event. Abstract PP31B-2251 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

192. J. Owens, S. Nielsen, C. Ostrander, L. Peterson, and A. Anbar (2015). Development and applications of thallium isotopes: a new proxy tracking the extent of manganese oxide burial. Abstract PP33E-04 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec. **Invited.**

193. *S. Rochelle, A. Anbar, H. Hartnett, S. Romaniello, and A. Poret-Pederson (2015). Developing a metal proxy for the rise of early terrestrial life. Abstract B21A-0415 presented at the 2015 Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

194. *F. Zhang, B. Kendall, H. Cui, A. D. Anbar, S. Xiao, and A. J. Kaufman (2015). An episode of widespread ocean anoxia during the latest Ediacaran period revealed by light U isotope compositions in carbonates. *Geological Society of America Abstracts with Programs* **47**: 705.

195. *F. Zhang, T. J. Algeo, S. J. Romaniello, A. D. Herrmann, S. Richoz, and A. D. Anbar (2015). Protracted global ocean anoxia delayed biotic recovery following the end-Permian mass extinction. *Geological Society of America Abstracts with Programs* **47**: 699.

196. S. Semken, G. Bruce, A. D. Anbar, S. Buxner, K. Karlstrom, and L. Crossey (2015). Complementary (not comparative) research on geoscience teaching and learning in virtual and in-situ field environments. *Geological Society of America Abstracts with Programs* **47**: 405.

197. A. D. Anbar (2015) Earth system oxygenation: toward an integrated theory of Earth evolution. 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August. **Invited (keynote).**

198. A. D. Anbar, G. W. Gordon, J. L. Skulan, S. M. Smith, and R. Fonseca (2015). Developing a clinically useful calcium isotope biomarker. 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August. **Invited.**

199. #G. W. Gordon, J. L. Skulan, and A. D. Anbar (2015). Ca isotope fractionation during bone formation. 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August.

200. A. D. Herrmann, G. W. Gordon, and A. D. Anbar (2015). U isotope variations in a dolomitized Jurassic carbonate platform (Tithonian; Southern Germany). 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August.

201. S. Olson, M. Roy, T. Lyons, C. Ostrander, and A. D. Anbar (2015). Inorganic hints of Archean oxygenation in the ~2.7 Ga Roy Hill Shale. 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August.

202. *F. F. Zhang, S. J. Romaniello, T. J. Algeo, A. D. Hermann, and A. D. Anbar (2015). U isotope variation in marine carbonates across the Permian-Triassic Boundary. 25th V. M. Goldschmidt Conference, Prague, Czech Republic, 16-21 August.

203. A. D. Anbar, D. Ben-Naim, D. Schönstein, and L. Horodyskyj (2015). The Inspark Science Network: Using astrobiology to teach science as exploration of the unknown, not just mastery of the known. Abstract #7790 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

204. #G. Bruce, S. Semken, R. Summons, L. Horodyskyj, B. Kotrc, S. Buxner, J. Swann, S. Klug-Boonstra, C. Oliver, and A. D. Anbar (2015). Interactive technology enabling a virtual exploration of our evolving planet. Abstract #7619 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

205. #L. Horodykyj, S. Buxner, D. Schönstein, S. Semken, and A. Anbar (2015). Increasing the impact of coursework through deep analytics. Abstract #7411 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

206. B. Kendall, R. A. Creaser, C. T. Reinhard, T. W. Lyons, and A. D. Anbar (2015). Osmium isotope evidence for transient episodes of Late Archean environmental oxygenation and oxidative continental weathering. Abstract #7392 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

207. H. J. Sun, C. P. McKay, A. Anbar, and G. Levin (2015). False positives: lessons from Viking and a new way forward. Abstract #7384 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

208. *F. F. Zhang, S. J. Romaniello, T. J. Algeo, A. D. Hermann, and A. D. Anbar (2015). U isotope variation in marine carbonates across the Permian-Triassic Boundary. Abstract #7629 presented at the 2015 Astrobiology Science Conference, Chicago, IL, 15 – 19 June.

209. A. Anbar, G. Bruce, S. Semken, R. Summons, S. Buxner , L. Horodyskij, B. Kotrc, J. Swann, S. Klug Boonstra, and C. Oliver (2014). Virtual exploration of Earth's evolution. Abstract ED34A-03 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

210. #G. Bruce, A. Anbar, S. Semken, R. Summons, C. Oliver, and S. Buxner (2014). iVFTs - immersive virtual field trips for interactive learning about Earth's environment. Abstract ED52A-1141 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

211. *X. Chen, S. Romaniello, A. Herrmann, L. Wasylenki and A. Anbar (2014). Uranium isotope fractionation during coprecipitation with aragonite and calcite. Abstract PP51C-1141 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

212. ¶K. Goto, T. Ito, K. Suzuki, A. Anbar, G. Gordon, T. Kashiwabara, Y. Takaya, G. Shimoda, T. Nozaki, S. Kiyokawa, G. Tetteh and F. Nyame (2014). A highly oxidized atmosphere–ocean system and oceanic molybdenum drawdown during the Paleoproterozoic. Abstract P11C-3786 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

213. #L. Horodyskyj, D. Schönstein, S. Buxner, S. Semken and A. Anbar (2014). Increasing Impact of Coursework Through Deep Analytics. Abstract ED31B-3437. presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

214. ¶S. Olson, C. Reinhard, N. Planavsky, T. Lyons, M. Roy and A. Anbar (2014). Oxygen oases before and after the GOE: insights from metals and models. Abstract P12A-08 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec. **Invited**.

215. *H. Smith, H. Kim, S. Romaniello, P. Field and A. Anbar (2014). A robust and fully-automated chromatographic method for the quantitative purification of Ca and Sr for isotopic analysis. Abstract PP51C-1143 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

216. #M. Roy, C. Ostrander, T. Lyons, S. Olson, R. Buick and A. Anbar (2014). Preliminary results from the AIDP-2 and AIDP-3 drill cores hint at systematic Mo enrichments in the ~2.65 Ga Roy Hill Shale. Abstract PP53A-1184 presented at the 2014 Fall Meeting, AGU, San Francisco, CA, 15-19 Dec.

217. #G. Bruce, S. Semken, A. D. Anbar, K. E. Karlstom, L. J. Crossery (2014). Explore and study Grand Canyon by immersive virtual field trip! *Geological Society of America Abstracts with Programs* **46**: 91.

218. #B. Kendall, R. A. Creaser, C. T. Reinhard and A. D. Anbar (2014). Confirmation of minimal post-depositional disturbance of rhenium and osmium in the 2.50 Ga Mt. McRae shale and osmium isotope evidence for Late Archean oxidative weathering. *Geological Society of America Abstracts with Programs* **46**: 201.

219. *C. Mead, S. Semken, A. D. Anbar (2014). The development of a valid and reliable biogeochemistry concept inventory. *Geological Society of America Abstracts with Programs* **46**: 312.

220. A. I. Sheen, B. Kendall, C. Reinhard, A. D. Anbar, R. A. Creaser, T. Lyons, A. Bekker, S. W. Poulton (2014). Quantitative constraints on the extent of Middle Proterozoic ocean anoxia from modeling of the oceanic mass balance of rhenium. *Geological Society of America Abstracts with Programs* **46**: 581.

221. ¶K. Goto, A. Anbar, G. Gordon, S. Romaniello, G. Shimoda, Y. Takaya, A. Tokumaru, T. Nozacki, K. Suzuki, S. Machida, T. Hanyu and A. Usui (2014). Uranium isotope in ferromanganese crusts: implications for the marine $^{238}U/^{235}U$ isotope system. 24th V. M. Goldschmidt Conference, Sacramento, CA, 8-13 June.

222. *X. Chen, S. Romaniello, A. Herrmann, L. Wasylenki and A. Anbar (2014). Uranium isotope fractionation during incorporation into aragonite and calcite. 24th V. M. Goldschmidt Conference, Sacramento, CA, 8-13 June.

223. *S. J. Romaniello, A. D. Herrmann and A. D. Anbar (2014). Progress, pitfalls, and future directions developing the $\delta^{238}U$ paleoredox proxy. 24th V. M. Goldschmidt Conference, Sacramento, CA, 8-13 June.

224. ¶T. W. Dahl, A. D. Anbar, G. W. Gordon and D. E. Canfield (2014). Iron cycling in Neoproterozoic ferruginous oceans. 24th V. M. Goldschmidt Conference, Sacramento, CA, 8-13 June.

225. A. D. Anbar (2013). Isotope innovations. Abstract PP44B-04 presented at the 2013 Fall Meeting, AGU, San Francisco, CA, 8-13 Dec. **Invited**.

226. D. R. Bell and A. D. Anbar (2013). Oxygen titration of continental lithosphere and the rise of atmospheric O_2. Abstract V41E-05 presented at the 2013 Fall Meeting, AGU, San Francisco, CA, 8-13 Dec.

227. #L. Horodyskyj, D. Ben-Naim, S. C. Semken and A. D. Anbar (2013). Transforming the online course. Abstract ED53E-0673 presented at the 2013 Fall Meeting, AGU, San Francisco, CA, 8-13 Dec.

228. *M. Neveu, A. T. Poret-Peterson, A. D. Anbar and J. J. Elser (2013). Ordinary stoichiometry of extraordinary microbes. Abstract B23F-0605 presented at the 2013 Fall Meeting, AGU, San Francisco, CA, 8-13 Dec.

229. S. K. Sahoo, G. Jiang, N. J. Planavsky, B. Kendall, J. D. Owens, A. D. Anbar and T. W. Lyons (2013). Ediacaran redox fluctuations. Abstract PP44B-05 presented at the 2013 Fall Meeting, AGU, San Francisco, CA, 8-13 Dec.

230. #G. W. Gordon, J. Monge, M. B. Channon, Q. Wu, J. Skulan, A. D. Anbar and R. Fonseca (2013). Calcium isotopic composition and its association with multiple myeloma disease activity. Abstract presented at the 55th American Society of Hematology Annual Meeting and Exposition, New Orleans, LA, Dec. 7-10.

231. A. D. Anbar, L. Horodyskyj, D. Ben-Naim and S. Semken (2013). Innovation online: inverting the lecture-lab paradigm in science education. *Geological Society of America Abstracts with Programs* **45**: 656.

232. #G. Bruce, A. D. Anbar, K. E. Karlstrom and L. J. Crossey (2013). Virtual field exploration of Grand Canyon geology and geologic history. *Geological Society of America Abstracts with Programs* **45**: 399.

233. M. Elrick, T. J. Algeo, V. J. Polyak, L. Zhao, Z. Q. Chen, A. Herrmann Y. Asmerom and A. D. Anbar (2013). Late Permian through early Triassic marine redox and continental weathering flux patterns interpreted from U and Nd isotopes: implications for end-Permian extinction models. *Geological Society of America Abstracts with Programs* **45**: 89.

234. S. K. Sahoo, G. Jiang, N. J. Planavsky, B. Kendall, J. D. Owens, A. D. Anbar and T. W. Lyons (2013). Turbulent times for early animals? *Geological Society of America Abstracts with Programs* **45**: 754.

235. A. Anbar and T. Lyons (2013). Redox-sensitive metals and their isotopes: the Holland legacy of early ocean exploration. Abstract presented at the 23rd V. M. Goldschmidt Conference, Florence, Italy, 25-30 August. *Mineralogical Magazine* **77:** 590.

236. #M. Channon, G. Gordon, Q. Schollenberger, J. Morgan, S. Smith and A. Anbar (2013). Understanding controls on Ca isotopes in human blood and urine. Abstract presented at the 23rd V. M. Goldschmidt Conference, Florence, Italy, 25-30 August. *Mineralogical Magazine* **77:** 853.

237. G. Gordon, J. Skulan, M. Channon, R. Fonseca and A. Anbar (2013). Early detection of osteolytic lesions in multiple myeloma using natural Ca isotopes. Abstract presented at the 23rd V. M. Goldschmidt Conference, Florence, Italy, 25-30 August. *Mineralogical Magazine* **77:** 1198.

238. A. Herrmann, T. Algeo, S. Romaniello, G. Gordon and A. Anbar (2013). Molybdenum and uranium isotope dynamics in a paleozoic epicontinental black shale. Abstract presented at the 23rd V. M. Goldschmidt Conference, Florence, Italy, 25-30 August. *Mineralogical Magazine* **77:** 1293.

239. R. Fonseca, J. Skulan, G. Gordon, and A. D. Anbar (2013). Early detection of osteolytic lesions in multiple myeloma using natural Ca isotopes. 14th International Myeloma Workshop, Kyoto, Japan. April 3-7.

240. A. D. Anbar, J. Skulan, G. Gordon and J. Morgan (2013). Metallomic markers in medicine. Abstract presented at the Pittcon 2013 Conference, Philadelphia, PA, March 17-21. **Invited**.

241. A. D. Anbar, B. Kendall, C. Reinhard and T. W. Lyons (2012). Evidence of environmental oxygenation before the Great Oxidation Event: a status report. Abstract B54B-02 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

242. M. P. Field, S. J. Romaniello, G. W. Gordon and A. D. Anbar (2012). Automated sample preparation for radiogenic and non-traditional metal isotope analysis by MC-ICP-MS. Abstract V23B-2823 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

243. A. D. Herrmann, G. W. Gordon, S. J. Romaniello, T. J. Algeo and A. D. Anbar (2012). Spatial heterogeneity of uranium isotope variations in a Phanerozoic, epicontintental black shale (Hushpuckney Shale, Swope Formation). Abstract B11G-04 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

244. A. Marcotte, B. J. Majestic, A. D. Anbar and P. Herckes (2012). The effect of particle size on iron solubility in atmospheric aerosols. Abstract A33D-0203 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

245. *C. Mead, P. Herckes, B. J. Majestic and A. D. Anbar (2012). Quantifying anthropogenic Fe in marine aerosols using Fe stable isotope analysis. Abstract OS41A-1698 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

246. *A. A. Monroe, P. Williams and A. D. Anbar (2012). Sampling and analysis of organic molecules in the plumes of Enceladus. Abstract P32A-07 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

247. *M. Neveu, A. T. Poret-Peterson, Z. M. Lee, A. D. Anbar and J. J. Elser (2012). Cell-sediment separation and elemental stoichiometries in extreme environments. Abstract B51D-0583 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

248. #A. T. Poret-Peterson, S. J. Romaniello, M. Bose, P. Williams, J. J. Elser, E. Shock, A. D. Anbar and H. E. Hartnett (2012). Abstract B51G-0646 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

249. P. Tsou, I. Kanik, D. Brownlee, C. McKay, A. Anbar, D. Glavin and H. Yano (2012). Returning samples from Enceladus. Abstract P33A-1920 presented at the 2012 Fall Meeting, AGU, San Francisco, CA, 3-7 Dec.

250. H. Pacheco, W. L. Taylor, S. Semken, A. E. Benbow, C. Mably, I. MacGregor, A. D. Anbar and W. Burelson (2012). Leveraging resources: AGI-ASU-NASA triad model for Earth and space science teacher professional development. *Geological Society of America Abstracts with Programs* **44**: 574.

251. A. Herrmann, S. Romaniello, P. Reid and A. Anbar (2012). U isotopes in marine calcareous algae: a paleo-redox proxy? Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June.

252. #A. Kelly, T. Lyons, E. Alsop, G. Love, N. Planavsky, B. Kendall and A. Anbar (2012). Geochemical perspectives on local versus global ocean redox at 1.64 Ga. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June. **Invited**.

253. #B. Kendall, A. Anbar, R. Creaser, T. Lyons, A. Bekker and S. Poulton (2012). Rhenium data from shales confirms ferruginous Proterozoic deep oceans. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June.

254. N. Monga, S. J. Romaniello and A. D. Anbar (2012). Isotopic fractionation of U(VI) during reduction by sulphide. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June.

255. *S. J. Romaniello, A. D. Herrmann and A. D. Anbar (2012). Incorporation and early diagenesis of Mo and U isotope records in Bahamian carbonate sediments. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June. **Invited**.

256. *S. R. Romaniello, G. Gordon, D. Wiederin, M. P. Field and A. D. Anbar (2012). Automated sample purification: Radiogenic and non-traditional metal isotopes in the 21st century. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June.

257. S. Sahoo, N. Planavsky, B. Kendall, X. Wang, X. Shi, A. Anbar, T. Lyons and G. Jiang (2012). Ocean redox changes in the wake of the Marinoan glaciation. Abstract presented at the 22nd V. M. Goldschmidt Conference, Montreal, Canada, 24-29 June.

258. A. D. Anbar, Y. Duan, B. Kendall, C. Reinhard, S. Severmann and T. W. Lyons (2011). A Multi-Proxy Paradigm in the Pursuit of Ocean Paleoredox. Abstract PP41E-05 presented at the 2011 Fall Meeting, AGU, San Francisco, CA, 4-9 Dec. **Invited**.

259. *G. L. Arnold, T. W. Lyons, G. W. Gordon and A. D. Anbar (2011). Extreme change in sulfide concentrations near the Bosporus Inlet (Black Sea) during the Little Ice Age tracked using molybdenum isotopes. Abstract PP51B-1846 presented at the 2011 Fall Meeting, AGU, San Francisco, CA, 4-9 Dec.

260. #L. Horodyskyj, D. Ben-Naim, A. D. Anbar and S. Semken (2011). Hunting for habitable worlds: engaging students in an adaptive online setting. Abstract ED24B-08 presented at the 2011 Fall Meeting, AGU, San Francisco, CA, 4-9 Dec.

261. K. Noonan, A. D. Anbar, F. Garcia-Pichel, A. T. Poret-Peterson and H. E. Hartnett (2011). Six siderophore-producing microorganisms identified in biological soil crusts. Abstract B32A-04 presented at the 2011 Fall Meeting, AGU, San Francisco, CA, 4-9 Dec.

262. J. Skulan, G. W. Gordon, J. Morgan, S. J. Romaniello, S. M. Smith and A. D. Anbar (2011). Natural Ca isotope composition of urine as a rapid measure of bone mineral balance. Abstract B54D-08 presented at the 2011 Fall Meeting, AGU, San Francisco, CA, 4-9 Dec.

263. *C. Mead, S. Semken and A. D. Anbar (2011). Identifying misconceptions about biogeochemistry among undergraduates. *Geological Society of America Abstracts with Programs* **43**: 68.

264. A. D. Anbar, B. Kendall, C. T. Reinhard and T. W. Lyons (2011). Whither the whiff? *Mineral. Mag.* **75**: 433. **Keynote**.

265. #B. Kendall, T. Komiya, T. W. Lyons, S. M. Bates, G. Jiang, R. A. Creaser, S. Xiao, K. McFadden, Y. Sawaki, M. Tahata, D. Shu, J. Han, Y. Li, X. Chu and A. D. Anbar (2011). First episode of widespread ocean oxygenation 551 Myr ago. *Mineral. Mag.* **75**: 1168. **Invited**.

266. T. W. Lyons, G. L. Arnold, A. Chappaz, B. C. Gill, N. J. Planavsky, C. T. Reinhard, N. Riedinger, C. T. Scott and A. D. Anbar (2011). Molybdenum as a paleoredox proxy: An update. *Mineral. Mag.* **75**: 1373. **Keynote**.

267. *J. L. L. Morgan, G. W. Gordon, S. J. Romaniello, J. L. Skulan, S. M. Smith and A. D. Anbar (2011). Rapidly assessing changes in bone mineral balance using natural stable calcium isotopes. *Mineral. Mag.* **75**: 1501.

268. #A. T. Poret-Peterson, S. J. Romaniello, N. Zolotova, Z. Martinez, J. J. Elser and A. D. Anbar (2011). Methylotrophy in Yellowstone National Park hot springs. *Mineral. Mag.* **75**: 1660.

269. *S. J. Romaniello, H. E. Hartnett, A. D. Anbar, J. J. Elser and E. L. Shock (2011). Nitrogen limitation in extremophilic hydrothermal ecosystems of Yellowstone National Park. *Mineral. Mag.* **75**: 1746.

S. K. Sahoo, G. Jiang, B. Kendall, N. J. Planavsky, X. Wang, X. Shi, A. D. Anbar and T. W. Lyons (2011). An oxygen window for early Ediacaran animal life. *Mineral. Mag.* **75**: 1778.

270. C. T. Scott, N. Planavsky, B. Kendall, B. Wing, A. Bekker, A. D. Anbar and T. W. Lyons (2011). Tracking Archean seawater trace metal inventories through multi-proxy analysis of euxinic black shales. *Mineral. Mag.* **75**: 1831. **Invited**.

271. L. E. Wasylenki, E. B. Wilkes and A. D. Anbar (2011). Is your clean lab full of zinc? *Mineral. Mag.* **75**: 2135.

272. S. Weyer, C. Montoya-Pino, G. W. Gordon, B. van de Schootbrugge, W. Oschmann, J. Pross and A. D. Anbar (2011). The extent of oceanic anoxic events revealed by correlated Mo- and U isotopes records. *Mineral. Mag.* **75**: 2151.

273. J. Owens, T. W. Lyons, S. Severmann, B. Gill, H. Jenkyns, M. M. M. Kuypers, G. Gordon, A. Anbar and W. Kuhn (2011). Global Perturbation of the Marine Iron Cycle During OAE-2. Climate and Ocean Dynamics of the Cretaceous Greenhouse World

274. A. E. Kelly, G. D. Love, T. W. Lyons and A. D. Anbar (2010). An integrated organic-inorganic geochemical study of the 1.64 Ga Barney Creek Formation in Australia. Abstract B51G-0429 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec. **Invited.**

275. #B. Kendall, G. W. Gordon, S. Poulton and A. D. Anbar (2010). Molybdenum isotope constraints on the extent of late Paleoproterozoic ocean euxinia. Abstract OS33E-1513 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

276. *C. Mead, A. D. Anbar, J. R. Lyons and T. M. Johnson (2010). Mass-independent fractionation of mercury isotopes in compact fluorescent light bulbs. Abstract V31B-2325 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

277. #A. T. Poret-Peterson, R. Schwegel, J. J. Elser, E. Shock and A. D. Anbar (2010). Diversity of membrane-bound nitrate reductase genes in geothermal springs. Abstract B51A-0335 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

278. R. Raiswell, C. Reinhard, A. Derkowski and A. D. Anbar (2010). Environmental changes recorded by syngenetic and early diagenetic iron minerals in the late Archean Mt. McRae Shale. Abstract B52B-03 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

279. #L. E. Wasylenki, G. Brennecka, J. Bargar, S. Weyer and A. D. Anbar (2010). EXAFS reveals the mechanism of U isotope fractionation during adsorption to Mn oxyhydroxide. Abstract PP22A-07 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

280. W. B. Wilkes, L. E. Wasylenki and A. D. Anbar (2010). Zinc finger takes on a whole new meaning: reducing and monitoring zinc blanks in the isotope lab. Abstract V51B-2183 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.

281. A. Herrmann, T. J. Algeo and A. D. Anbar (2010). Do uranium isotopes of epicontinental black shales reflect global oceanic conditions? *Geological Society of America Abstracts with Programs* **42**: 467.

282. T. W. Lyons, A. D. Anbar, A. Bekker, B. Kendall, C. Li, G. D. Love, P. Mcgoldrick, N. J. Planavsky, R. Raiswell, C. T. Reinhard, C. Scott (2010). New view of the old ocean: a prevalence of deep iron and marginalized sulfide from the late archean through the proterozoic. *Geological Society of America Abstracts with Programs* **42**: 560.

283. R. Raiswell, C. Reinhard, A. Derkowski, J. Owens, S. Bottrell, A. D. Anbar and T. W. Lyons (2010). Formation of syngenetic and early diagenetic iron minerals in the late Archean Mt. McRae Shale: paleoceanographic implications. *Geological Society of America Abstracts with Programs* **42**: 560.

284. #L. E. Wasylenki, L. J. Liermann, J. Nuester, A. D. Anbar, S. L. Brantley (2010). Fe isotope fractionation and kinetics of Fe release during dissolution of two very different amphiboles. *Geological Society of America Abstracts with Programs* **42**: 557.

285. A. D. Anbar, Y. Duan and B. Kendall (2010). Early oxygen. GeoCanada 2010, Calgary, Alberta, CA, 10-14 May. **Invited.**

286. K. Alexander, K. Lui, T. Viliboroghi, A. Anbar, F. Garcia-Pichel, and H. E. Hartnett (2010). Response of biological soil crusts to porewater metal additions. Astrobiology Science Conference 2010, League City, TX, 26-29 April.

287. A. D. Anbar (2010). Habitable Worlds: astrobiology meets sustainability in the virtual realm. Astrobiology Science Conference 2010, League City, TX, 26-29 April. **Invited**.

288. A. D. Anbar, Y. Duan and B. Kendall (2010). Early oxygen. Astrobiology Science Conference 2010, League City, TX., 26-29 April. **Invited**.

289. A. D. Anbar, E. S. Boyd, R. Buick, M. Claire, D. Des Marais, D. Domagal-Goldman, J. Eigenbrode, D. Erwin, K. Freeman, R. Hazen, C. Johnson, T. Lyons, V. Meadows, H. Ohmoto, S. Ono, J.W. Peters, B. Shapiro, R. Summons and M. Walter (2010). An Archean Biosphere Initiative. Astrobiology Science Conference 2010, League City, TX, 26-29 April. **Invited**.

290. E. S. Boyd, A. D. Anbar, S. Miller, T. L. Hamilton, M. Lavin and J. W. Peters (2010). An early origin for molybdenum-nitrogenase. Astrobiology Science Conference 2010, League City, TX, 26-29 April.

291. #J. B. Glass, F. L. Wolfe-Simon, A. T. Poret-Peterson and A. D. Anbar (2010). Signatures of low-Mo ancient ocean may be preserved in cyanobacterial genomes. Astrobiology Science Conference 2010, League City, TX. Astrobiology Science Conference 2010, League City, TX, 26-29 April.

292. H. E. Hartnett, S. Romaniello, B. Johnson, M. Kyle, T. Anderson, A. D. Anbar, J. Elser and E. Shock (2010). Geochemical evidence for denitrification in a Yellowstone National Park hot spring. Astrobiology Science Conference 2010, League City, TX, 26-29 April.

293. #B. Kendall, G. Brennecka, S. Weyer and A. D. Anbar (2010). Onset of oxidative uranium mobilization on the late Archean Earth? Astrobiology Science Conference 2010, League City, TX, 26-29 April.

294. #A. T. Poret-Peterson, R. Schwegel, M. Knowlton, J. J. Elser, E. L. Shock and A. D. Anbar (2010). Denitrification in hot environments: a gene perspective. Astrobiology Science Conference 2010, League City, TX, 26-29 April.

295. J. D. Blum, A. D. Anbar (2010). Mercury isotopes in the late Archean Mount McRae Shale, *Geochim. Cosmochim. Acta* **74:** A98.

296. T. W. Dahl, E. Hammarlund, A. H. Knoll, A.D. Anbar, D. E. Canfield (2010). Ocean oxygenation after the rise of animals. *Geochim. Cosmochim. Acta* **74**: A202.

297. *C. Mead, A. D. Anbar, T. M. Johnson (2010). Mass-independent fractionation of Hg isotopes resulting from photochemical self-shielding, *Geochim. Cosmochim. Acta* **74**: A693.

298. S. Severmann, J. Mcmanus, R. Poulson-Brucker, J. Owens, T. Lyons, A. Anbar, G. Gordon (2010). Of modern lakes and ancient oceans: Trace metals and their isotopes in an anoxic African rift lake. *Geochim. Cosmochim. Acta* **74**: A936.

299. #L. E. Wasylenki, G. A. Brennecka, J. R. Bargar, A. D. Anbar (2010). The mechanism of uranium isotope fractionation during adsorption to Mn oxyhydroxide. *Geochim. Cosmochim. Acta* **74:** A1116.

300. K. Alexander, D. Lui, A. D. Anbar, G. Garcia-Pichel and H. E. Hartnett (2009). Effect of nitrogen and metal additions on nitrogen fixation activity in biological soil crusts. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract EP53C-0628.

301. [#]B. Kendall, C. Reinhard, T. W. Lyons, A. J. Kaufman and A. D. Anbar (2009). Late Archean surface ocean oxygenation. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract B12A-01. **Invited**.

302. C. Reinhard, R. Raiswell, C. Scott, A. D. Anbar and T. W. Lyons (2009). Oxidative weathering and euxinia in the Late Archean. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract B12A-03. **Invited**.

303. [*]S. J. Romaniello, G. Brennecka, A. D. Anbar and A. S. Colman (2009). Natural isotopic fractionation of $^{238}U/^{235}U$ in the water column of the Black Sea. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract V54C-06.

304. [#]L. E. Wasylenki, G. Montanez and A. D. Anbar (2009). Cd isotope fractionation during adsorption varies with salinity. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract V11C-1977.

305. S. Weyer, G. Brennecka, C. Montoya Pino, J. Noordmann, E. A. Schauble, M. Wadhwa and A. D. Anbar (2009). Natural variation of $^{238}U/^{235}U$ in geo- and cosmochemistry. *EOS Trans. AGU* **90**, Fall Meeting Supplement, Abstract V54C-05.

306. [*]G. A. Brennecka, A. D. Herrmann, M. R. Saltzman and A. D. Anbar (2009). Using $^{238}U/^{235}U$ ratios in carbonates as a paleoredox indicator: variations across the Permian-Triassic boundary. *Geological Society of America Abstracts with Programs* **41**: 566.

307. [#]B. Kendall, C. Reinhard, T. W. Lyons, A. J. Kaufman and A. D. Anbar (2009). Surface ocean oxygenation preceded the Great Oxidation Event. *Geological Society of America Abstracts with Programs* **41**: 45.

308. [¶]T. W. Dahl, A. D. Anbar, G. W. Gordon, M. T. Rosing, R. E. Frei, and D. E. Canfield (2009). Do $\delta^{98}Mo$ values in marine euxinic sediments reflect seawater? *Geochim. Cosmochim. Acta* **73**: A257 Suppl.

309. B. C. Gill, B. C., T. W. Lyons, T. Dahl, M. Saltzman, G. Gordon and A. D. Anbar (2009). Multiple geochemical proxies reveal a Late Cambrian ocean anoxic event. *Geochim. Cosmochim. Acta* **73**: 436 Suppl. **Invited.**

310. T. W. Lyons, C. Scott, C. Reinhard and A. D. Anbar (2009). Euxinia in the Proterozoic ocean, trace metal abundances, and the potential impacts on life. *Geochim. Cosmochim. Acta* **73**: A807 Suppl. **Invited.**

311. C. Montoya Pino, S. Weyer, B. van de Schootbrugge, A. D. Anbar, H. W. Arz, W. Oschmann and J. Pross (2009). Global versus regional anoxia during the OAE-2 and the T-OAE. *Geochim. Cosmochim. Acta* **73**: A897 Suppl.

312. [#]L. E. Wasylenki, C. L. Weeks, T. G. Spiro, J. R. Bargar and A. D. Anbar (2009). How Mo isotopes fractionate during adsorption to Mn and Fe oxyhydroxides. *Geochim. Cosmochim. Acta* **73**: A1419 Suppl. **Keynote.**

313. S. Weyer, G. Brennecka, J. Zipfel, M. Wadhwa and A. D. Anbar (2009). U isotope variations in CAIs: Implications for the age of the Solar System. *Geochim. Cosmochim. Acta* **73**: A1433 Suppl.

314. E. A. Prevedorou, M. Diaz-Zorita Bonilla, J. E. Buikstra, G. Gordon, A. Anbar and K. J. Knudson (2009). Residential mobility and dietary patterns at the prehistoric site of Gatas, Southeastern Spain. Annual Meeting of the American Association of Physical Anthropologists.

315. T. Algeo, G. Gordon, A. Anbar, P. Sauer, L. Schwark, S. Bates, T. Lyons, S. Turgeon, R. Creaser, B. Nabbfeld and K. Grice (2008). New insights on the Frasnian/Famennian mass extinction: a role for soil erosion? *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract PP33D-04.

316. A. D. Anbar and F. Wolfe-Simon (2008). The bioinorganic bridge between life and environment. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract PP14A-01. **Invited.**

317. K. Bradley, B. Weiss, L. Carporzen, A. Anbar and R. Buick (2008). Paleomagnetism of the Astrobiology Drilling Project 8 drill core, Pilbara, Western Australia: implications for the early geodynamo and Archean tectonics. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract V12B-04.

318. J. Crawford, J. Black, L. Wasylenki, G. Gordon, A. Anbar and A. Kavner (2008). Electrochemical fractionation of molybdenum stable isotopes. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract B21B-0361.

319. [*]J. B. Glass, F. Wolfe-Simon and A. D. Anbar (2008). Molybdenum storage in cyanobacteria: "mopping" up excess Mo. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract B21B-0343.

320. T. W. Lyons, C. Scott, B. C. Gill and A. D. Anbar (2008). Trace Metals in the Early Ocean, Biological Implications, and Evolving Biospheric Redox. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract B24C-02.

321. C. T. Reinhard, R. Raiswell, A. Anbar and T. Lyons (2008). An Episode of Late Archean Euxinia and Enhanced Continental Weathering Revealed by Iron Speciation in the Mt. McRae Shale. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract PP21B-1411.

322. M. A. Saito, E. M. Bertrand and A. Anbar (2008). Neoproterozoic Oxygenation of Earth Surface Environments Reflected in the Late Evolution of the O_2-Dependent Vitamin B12 Biosynthesis Pathway. *Eos Trans. AGU* **89**, Fall Meet. Suppl., Abstract B24C-04.

323. A. D. Anbar and M. Claire (2008). O_2 variability in Archean environments: do whiffs trump tiffs? *Geochim. Cosmochim. Acta* **72**: A22 Suppl. **Invited**.

324. A. D. Anbar and G. W. Gordon (2008). Redox renaissance. *Geochim. Cosmochim. Acta* **72**: A22 Suppl. **Keynote**.

325. *G. Brennecka, L. E. Wasylenki, S. Weyer and A. D. Anbar (2008). Experiments demonstrate that Uranium isotopes fractionate during adsorption to Mn-oxides. *Geochim. Cosmochim. Acta* **72**: A114 Suppl.

326. ¶T. W. Dahl, A. D. Anbar, G. W. Gordon, M. T. Rosing, R. E. Frei and D. E. Canfield (2008). Molybdenum isotope variations in a redox-stratified lake; Removal mechanism and preservation in euxinic sediments. *Geochim. Cosmochim. Acta* **72**: A194 Suppl.

327. *Y. Duan, G. L. Arnold, G. W. Gordon and A. D. Anbar (2008). Evidence from Mo isotopic compositions for "A whiff of oxygen" before the Great Oxidation Event. *Geochim. Cosmochim. Acta* **72**: A228 Suppl.

328. J. Neuster, L. J. Liermann, L. E. Wasylenki, A. D. Anbar and S. L. Brantley (2008). Does Iron dissociation from siderophores lead to Iron isotope fractionation? *Geochim. Cosmochim. Acta* **72**: A692 Suppl.

329. C. Reinhard, R. Raiswell, A. Anbar and T. Lyons. (2008). Oxidative weathering and the Fe-S balance of the late Archean ocean. *Geochim. Cosmochim. Acta* **72**: A784 Suppl.

330. L. E. Wasylenki, C. L. Weeks, T. G. Spiro, J. R. Bargar and A. D. Anbar (2008). How does metal adsorption cause isotopes to apportion? *Geochim. Cosmochim. Acta* **72**: A1007 Suppl.

331. A. D. Anbar, A. J. Kaufman, G. Arnold, R. Buick, R. Creaser, Y. Duan, J. Farquhar, J. Garvin, D. Johnston, B. Kendall, T. W. Lyons and C. Scott (2008). A whiff of oxygen before the Great Oxidation Event. *Astrobiology* **8**: 319.

332. *J. B. Glass, F. Wolfe-Simon and A. D. Anbar (2008). The co-evolution of nitrogen and molybdenum biogeochemical cycles: Mo requirements for nitrogen assimilation in diazotrophic heterocystous cyanobacteria. *Astrobiology* **8**: 357.

333. H. Hartnett, K. Alexander, F. Garcia-Pichel and A. Anbar (2008). Production of dissolved organic carbon by desert biological soil crusts during simulated rainfall experiments. *Astrobiology* **8**: 428.

334. T. Lyons, W. Gilhooly, C. Reinhard, G. Love and A. Anbar (2008). The challenge of distinguishing between marine and nonmarine deposition on early Earth. *Astrobiology* **8**: 323.

335. #L. E. Wasylenki, T. J. Lund and A. D. Anbar (2008). Mo isotopes fractionate during adsorption to hydrous ferric oxide: Implications for Mo isotopes in Archean and Proterozoic oceans (2008). *Astrobiology* **8**: 325.

336. ¶S. Weyer, A. Anbar, E. Schauble (2008). Natural fractionation of uranium isotopes and ocean paleoredox. *Astrobiology* **8**: 326.

337. #F. Wolfe-Simon, P. Davies and A. D. Anbar (2008). Did nature also choose arsenic? *Astrobiology* **8**: 360.

338. ¶S. Weyer, E. A. Schauble and A. D. Anbar (2007). Nuclear volume-dependent fractionation of uranium isotopes. *EOS Trans. AGU* **88**, Fall Meet. Suppl., Abstract V41E-04. **Invited**.

339. A. D. Anbar, F. Wolfe-Simon and J. Elser (2007). Elements of Life. *Geological Society of America Abstracts with Programs*, **39**: 125. **Invited**.

340. *Y. Duan, A. D. Anbar, G. L. Arnold, G. W. Gordon, S. Severmann and T. W. Lyons (2007). Iron isotope variations in the ~2.5 Ga Mt. McRae Shale. *Geological Society of America Abstracts with Programs*, **39**: 449.

341. J. Skulan, A. D. Anbar and T. D. Bullen (2007). Medical applications of calcium and other "non-traditional" stable isotope systems. *Geological Society of America Abstracts with Programs*, **39**: 296. **Invited**.

342. A. D. Anbar and S. Weyer (2007). Isotope fractionation: Happy hunting across the Periodic Table. *2007Meeting of the Federation of Analytical Spectroscopy Societies (FACSS)*, Memphis, TN. **Invited**.

343. A. D. Anbar, Y. Duan, T. W. Lyons, G. L. Arnold, B. Kendall, R. A. Creaser, A. J. Kaufman, G. Gordon, C. Scott, J. Garvin and R. Buick (2007). A whiff of oxygen before the Great Oxidation Event? *Geochim. Cosmochim. Acta* **71**: A24 Suppl.

344. ¶T. W. Dahl, A. D. Anbar, G. W. Gordon, R. Frei, and D. E. Canfield (2007). Mo isotope variations in meromictic Lake Cadagno. *Geochim. Cosmochim. Acta* **71**: A196 Suppl.

345. A. J. Kaufman, D. T. Johnston, J. Farquhar, A. L. Masterson, T. W. Lyons, S. Bates, A. D. Anbar, G. L. Arnold, J. Garvin and R. Buick (2007). Late Archean biospheric oxygenation and atmospheric evolution. *Geochim. Cosmochim. Acta* **71**: A469 Suppl.

346. K. Konhauser, S. Lalonde, L. Amskold, N. Posth, A. Kappler and A. D. Anbar (2007). Decoupling photochemical Fe(II) oxidation from shallow-water BIF deposition. *Geochim. Cosmochim. Acta* **71**: A509 Suppl.

347. #L. E. Wasylenki, A. D. Anbar and S. L. Brantley (2007). The role of organic ligands in Fe isotope fractionation during dissolution of hornblende. *Geochim. Cosmochim. Acta* **71**: A1092 Suppl.

348. ¶S. Weyer, A. D. Anbar, A. Gerdes, G. L. Arnold, G. Gordon, J. McManus and E. A. Boyle (2007). Uranium "stable" isotope fractionation in nature: A potential paleo redox- and bio-tracer? *Geochim. Cosmochim. Acta* **71**: A1105 Suppl.

349. ¥U. Ryb, A. Matthews, Y. Erel, G. Gordon and A. Anbar (2007). Large molybdenum isotope variations in a continental rift setting. *Geophys. Res. Abstracts* **9**: 02928. SRef-ID: 1607-7962/gra/EGU2007-A-02928.

350. A. D. Anbar (2007). Potential insights into the evolution of the metallome from metal stable isotopes. *ASLO Aquatic Sciences Meeting,* Santa Fe, NM. **Invited**.

351. [#]F. Wolfe-Simon, A. Diamond, J. Morgan, J.J. Elser and A. D. Anbar (2007). Evolutionarily significant differences between prokaryotic and eukaryotic responses to Fe stress. *ASLO Aquatic Sciences Meeting,* Santa Fe, NM.

352. [*]J. B. Glass, M. L. Krieg, F. Wolfe-Simon and A. D. Anbar (2007). Trace metal controls on the efficiency of nitrogen fixation: assessing microbial metal requirements in ancient oceans. *ASLO Aquatic Sciences Meeting,* Santa Fe, NM.

353. K. Alexander, H. Hartnett, A. Anbar, H. Beraldi and F. Garcia-Pichel (2006). Isotopic composition of organic and inorganic carbon in desert biological soil crust systems. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract B13C-1116.

354. A. D. Anbar (2006). Heavy stable isotopes: From exceptional to expected. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract V12A-01. **Invited**.

355. A. D. Anbar, L. Wasylenki, L. Liermann, R. Mathur and S. Brantley (2006). Isotope fractionation during microbial metal assimilation. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract V14C-05.

356. [#]G. W. Gordon, A. D. Anbar, K. MacLeod and T. Lyons (2006). Mo isotopes during OAE2. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract PP41B-1205.

357. [¥]S. Severmann, J. McManus, J. Owens, T. W. Lyons, G. Gordon and A. Anbar (2006). Combined Fe-S stable isotopes in modern anoxic environments and the effect of Fe versus S limitation. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract PP13C-01. **Invited**.

358. [#]C. Siebert, S. Staton, P. Andersson and A. Anbar (2006). Molybdenum in the Baltic Sea. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract PP21C-1712.

359. [#]L. Wasylenki, B. Rolfe and A. Anbar (2006). Effect of ionic strength on Mo isotope fractionation during adsorption to Mn-oxyhydroxide. *Eos Trans. AGU* **87**, Fall Meet. Suppl., Abstract PP13C-04.

360. [¶]C. Scott, T. W. Lyons, A. Bekker, A. D. Anbar and G. Williams (2006). Geochemical evidence for the restriction of oxic depositional environments in the Proterozoic ocean. *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

361. [*]Y. Duan, A. D. Anbar, G. L. Arnold, T. Lyons, A. J. Kaufman, G. Gordon, R. Buick and J. Garvin (2006). Molybdenum concentration and isotopic composition in the ~ 2.5 Ga McRae Shale, Hamersley Basin, Western Australia: An early whiff of oxygen? *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

362. A. Herrmann, L. Waslyenki and A. D. Anbar (2006). Molybdenum isotope record of the Hushpuckney shale (Missourian Stage, Eastern Kansas): implications for regional and global anoxia. *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

363. A. J. Kaufman, J. Farquhar, D. T. Johnston, T. W. Lyons, R. Buick, A. Anbar, G. L. Arnold, J. Garvin and S. Bates (2006). The preservation of non-mass dependent sulfur isotope anomalies in

a deep time astrobiology drill core from Western Australia. *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

364. ¶B. Kendall, A. D. Anbar, G. Gordon, G. L. Arnold and R. A. Creaser (2006). Constraining the redox state of the Proterozoic deep oceans using the Mo isotope systematics of euxinic black shales. *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

365. ¥S. Severmann, T. Lyons, A. Anbar, G. Gordon and J. McManus (2006). The isotopic expression of iron shuttling in the euxinic Black Sea basin and implications for the rise of oxyen in the early atmosphere. *2006 Meeting of the Geological Society of America,* Philadelphia, PA.

366. #G. W. Gordon, A. D. Anbar, K. MacLeod and T. Lyons (2006). Evaluation of the Mo isotope paleoredox proxy in Late Cretaceous ocean sediments. *Geochim. Cosmochim. Acta* **70**: A209 Suppl.

367. ¶S. Severmann, T. W. Lyons, Y. Duan, A. Anbar, G. Gordon and J. McManus (2006). The isotopic expression of Fe shuttling in modern and ancient euxinic sediments: implications for the rise of oxygen. *Geochim. Cosmochim. Acta* **70**: A572 Suppl.

368. #L. E. Wasylenki, A. D. Anbar and G. W. Gordon (2006). Temperature dependence of Mo isotope fractionation during adsorption to δ-MnO_2: implications for the paleoredox proxy. *Geochim. Cosmochim. Acta* **70**: A691 Suppl.

369. #L. E. Wasylenki, R. D. Mathur, L. J. Liermann, A. D. Anbar and S. L. Brantley (2006). Toward multi-element isotopic biosignatures: experimental investigation of microbial metal assimilation. *Geochim. Cosmochim. Acta* **70**: A691 Suppl.

370. A. Bekker, Y. Shen, M. Kacanda, T. Lyons, F. Kenig, A. Anbar and O. Rouxel (2006). Redox state of the deep ocean during the 2.22-2.1 Ga carbon isotope excursion. *Eos Trans. AGU* **87**, Jt. Assem. Suppl., Abstract U51A-03. **Invited.**

371. *S. Staton, L. Amskold, G. Gordon, A. Anbar and K. Konhauser (2006). Iron isotope fractionation during photo-oxidation of aqueous ferrous iron. *Eos Trans. AGU* **87**, Jt. Assem. Suppl., Abstract V44A-04.

372. A. D. Anbar and T. W. Lyons (2006). Insight into ocean redox evolution from metals and metal isotopes. *Astrobiology* **6**: 100. **Invited.**

373. A. D. Anbar, L. Wasylenki, L. Liermann and S. Brantley (2006). Isotopic Fingerprints of Microbial Metal Assimilation. *Astrobiology* **6**: 165.

374. #L. E. Wasylenki, A. D. Anbar and G. Gordon (2006). Temperature dependence of the molybdenum isotope paleoredox proxy. *Astrobiology* **6**: 164.

375. *Y. Duan, A. D. Anbar, G. Gordon, S. Severmann, T. W. Lyons and B. Sageman (2006). Investigation of iron isotope systematics in Middle Devonian anoxic basins. *Astrobiology* **6**: 202.

376. *S. J. R. Staton, L. Amskold, G. Gordon, A. D. Anbar and K. O. Konhauser (2006). Iron isotope fractionation during photo-oxidation of aqueous ferrous iron. *Astrobiology* **6**: 215.

377. A. J. Kaufman, J. Farquhar, D. T. Johnston, T. W. Lyons, G. L. Arnold and A. Anbar (2006). Rapid time series $\Delta^{33}S$ profiles of deep time drill cores by EA combustion techniques. *Astrobiology* **6**: 136.

378. ¶C. Scott, T. W. Lyons, A. Bekker, A. Anbar and Y. Duan (2006). Mo-enrichment in Precambrian organic-rich shales: a proxy of atmospheric and ocean redox state. *Astrobiology* **6**: 164.

379. L. Amskold, A. Anbar and K. Konhauser (2006). Banded iron formations in the Archaean: Was photo-oxidation the mechanism responsible for the deposition of Fe? *Astrobiology* **6**: 197.

380. R. Grymes, H. Ohmoto, R. Buick, A. Anbar, R. Summons and S. D'Hondt (2006). The astrobiology drilling program: update. *Astrobiology* **6**: 238.

381. A. D. Anbar (2006). Transition Metal and Other Non-Traditional Stable Isotopes: Novel Applications of MC-ICP-MS. *Winter Plasma Conference*, Tucson, Arizona, 2006. **Invited.**

382. ¶S. Severmann, T. W. Lyons, J. McManus, A. D. Anbar and G. Gordon (2005). What can Fe isotopes in anoxic environments tell us about the rise of oxygen in the coupled land-ocean-atmosphere system? – Clues from the Black Sea. *Eos Trans. AGU* **86**, Fall Meet. Suppl., Abstract PP33D-02.

383. A. D. Anbar (2005). Possible biological implications of mid-Proterozoic ocean anoxia. Paper No. 49-4, *Earth System Processes 2*, Calgary, Canada. **Invited**.

384. A. D. Anbar, P. Tackley and L. Wasylenki (2005). Constraints on Archean oxygen from mantle isotope sytematics. Paper No. 11-6, *Earth System Processes 2*, Calgary, Canada.

385. ¶S. Severmann, A. D. Anbar, T. W. Lyons and J. McManus (2005). Fe cycling in modern and ancient anoxic environments and future directions for the Fe isotope paleoproxy. Paper No. 45-1, *Earth System Processes 2*, Calgary, Canada.

386. ¶C. Scott, T. W. Lyons, A. D. Anbar, A. Bekker, S. Poulton and D. Canfield (2005). Trace metals in Precambrian black shales and the evolving redox state of the early ocean. Paper No. 45-7, *Earth System Processes 2*, Calgary, Canada.

387. A. D. Anbar and G. A. Williams (2005). Molybdenum isotope prospects. *Geochim. Cosmochim. Acta* **69**: A550 Suppl. (*15th V. M. Goldschmidt Conference,* Moscow, Idaho).

388. A. D. Anbar (2005). Stoichiometric linkages between major and minor elements in evolution. *American Society of Limnology and Oceanography (ASLO) Aquatic Sciences Meeting*, Salt Lake City, Utah.

389. ¶C. T. Scott, T. W. Lyons and A. D. Anbar (2004). Temporal trends in Mo enrichment in Precambrian black shales as an indicator of Earth's oxidative history. *Geochim. Cosmochim. Acta* **69**: A787 Suppl. (*14th V. M. Goldschmidt Conference,* Copenhagen, Denmark).

390. S. Weyer, A. Woodland, C. Münker, G. L. Arnold, R. Chakrabarti and A. D. Anbar (2004). Iron isotope variations in the Earth's mantle and the terrestrial planets. *Geochim. Cosmochim. Acta* **69**: A736 Suppl. (*14th V. M. Goldschmidt Conference,* Copenhagen, Denmark).

391. A. D. Anbar (2004). Molybdenum stable isotope biogeochemistry. *2004 Water-Rock Interaction meeting*, Saratoga Springs, NY. **Invited.**

392. A. D. Anbar (2004). Metal isotopes and metallomics. *2004 meeting of the Federation of Analytical Spectroscopy Societies (FACSS)*, Portland, OR. **Invited.**

393. A. D. Anbar (2004). Possible biological implications of mid-Proterozoic ocean anoxia. *2004 Meeting of the Geological Society of America,* Denver, CO.

394. C. Scott, T. W. Lyons and A. D. Anbar (2004). Temporal trends in trace metal enrichment in precambrian black shales and oxidation of surface environments. *2004 Meeting of the Geological Society of America,* Denver, CO.

395. #G. Williams, A. D. Anbar, T. Lyons, B. Sageman and G. Arnold (2004). The redox state of Devonian oceans: Mo isotope evidence. *2004 Meeting of the Geological Society of America,* Denver, CO.

396. A. D. Anbar and E. Shock (2004). Biogeoscience from a metallomic and proteomic perspective. *Eos Trans. AGU* **85**, Fall Meet. Suppl., Abstract B51D-01.

397. #G. Williams, A. D. Anbar, G. L. Arnold and T. W. Lyons (2004). Tracking changes in ocean oxygenation with molybdenum isotopes. *Eos Trans. AGU* **85**, Fall Meet. Suppl., Abstract B53C-1010.

398. J. Skulan, A. D. Anbar, T. Bullen and S. Smith (2004). Natural variations in calcium isotope composition as a monitor of bone mineral balance in humans. *Eos Trans. AGU* **85**, Fall Meet. Suppl., Abstract V51A-0517.

399. A. D. Anbar, R. Buick, T. W. Lyons, A. J. Kaufman, A. H. Knoll and R. Summons (2004). Integrated paleoecological and paleoenvironmental investigation of a Late Archean drill core. *2004 Astrobiology Science Conference*, NASA Ames Research Center, Mountain View, CA

400. A. D. Anbar, R. Buick and S. J. Mojzsis (2004). Missions to the early Earth: Drilling and other projects on the Earth and beyond. *2004 Astrobiology Science Conference*, NASA Ames Research Center, Mountain View, CA

401. *G. L. Arnold and A. D. Anbar (2004). Mo isotopes as indicators of global paleoredox. *2004 Astrobiology Science Conference*, NASA Ames Research Center, Mountain View, CA

402. #G. Williams, A. D. Anbar and G. L. Arnold (2004). Reliability of black shales as recorders of marine molybdenum isotopes and paleoredox. *2004 Astrobiology Science Conference*, NASA Ames Research Center, Mountain View, CA

403. *G. L. Arnold, A. D. Anbar, T. W. Lyons and G. Williams (2003). Molybdenum isotopes in black shales. *2003 Meeting of the Geological Society of America*, Seatttle, WA.

404. T. W. Lyons, A. D. Anbar, B. C. Gill, S. R. Meyers, B. B. Sageman, A. M. Cruse, P. Wilde and C. T. Scott (2003). Molybdenum accumulation in organic-rich sediments and sedimentary rocks. *2003 Meeting of the Geological Society of America*, Seatttle, WA.

405. A. D. Anbar and T. M. Johnson (2003). Oxyanion stable isotopes and ocean paleoredox. *13th V. M. Goldschmidt Conference,* Kurashiki, Japan.

406. A. Jarzecki, A. D. Anbar and T. Spiro (2003). Iron isotope fractionation between $Fe(H_2O)_6^{2+}$ and $Fe(H_2O)_6^{3+}$. *13th V. M. Goldschmidt Conference,* Kurashiki, Japan.

407. #G. W. Williams, A. D. Anbar and G. L. Arnold (2003). Preservation of molybdenum isotope signatures in black shales. *13th V. M. Goldschmidt Conference,* Kurashiki, Japan.

408. A. D. Anbar, A. Jarzecki and T. Spiro (2003). Modeling equilibrium Fe isotope fractionation. *AGU-EUG-EGS joint meeting*, Nice, France.

409. S. Weyer, G. L. Arnold, R. Chakrabarti and A. D. Anbar (2003). Iron isotope fractionation at high temperatures. *AGU-EUG-EGS joint meeting*, Nice, France.

410. A. D. Anbar, R. Buick, R. Grymes, S.. Mojzsis, M. Nedachi, H. Ohmoto and B. Runnegar (2003). The Astrobiology Drilling Program of the NASA Astrobiology Institute. *AGU-EUG-EGS joint meeting*, Nice, France.

411. A. D. Anbar, R. L. Guynn, L. J. Liermann, G. Icopini, J. Barling and S. L. Brantley (2003). Fe isotope fractionation during silicate weathering. *AGU-EUG-EGS joint meeting*, Nice, France.

412. A. D. Anbar, R. Buick, R. Grymes, S. Mojzsis, M. Nedachi, H. Ohmoto and B. Runnegar (2003). The Astrobiology Drilling Program of the NASA Astrobiology Institute. *AGU-EUG-EGS joint meeting*, Nice, France.

413. *G. L. Arnold, A. D. Anbar and J. Barling (2003). Molybdenum isotopes and oxygenation of the mid-Proterozoic ocean. *NASA Astrobiology Institute Annual Meeting*, Tempe, AZ.

414. *G. L. Arnold, A. D. Anbar and J. Barling (2002). Molybdenum isotopes and oxygenation of the mid-Proterozoic ocean. *EOS Trans. AGU* ***83***, Fall Meet. Suppl., Abstract V22D-09, 2002.

415. A. D. Anbar and A. H. Knoll (2002). Sulfur isotopes as paleoenvironmental indicators: Evolutionary implications. *2002 Meeting of the Geological Society of America*, Denver, CO.

416. *G. L. Arnold, A. D. Anbar and J. Barling (2002). Oxygenation of Proterozoic oceans: Insight from molybdenum isotopes. *12th V. M. Goldschmidt Conference,* Davos, Switzerland.

417. A. D. Anbar, G. L. Arnold, R. Rye and S. Weyer (2002). Iron isotopes in an Archean paleosol. *12th V. M. Goldschmidt Conference,* Davos, Switzerland. **Invited**.

418. #J. Barling and A. D. Anbar (2002). Mass-dependent fractionation of molybdenum isotopes scavenged by manganese oxyhydroxides. *12th V. M. Goldschmidt Conference,* Davos, Switzerland.

419. A. D. Anbar, R. Rye and A. J. Kaufman (2001). Explaining the Paleoproterozoic rise of O_2. *Eos Trans. AGU* ***82***, all Meet. Suppl., Abstract P21C-09, 2001.

420. #J. Barling and A. D. Anbar (2001). Experimental study of mass-dependent fractionation of molybdenum isotopes scavenged during precipitation of manganese oxyhydroxides. *Eos Trans. AGU* ***82***, Fall Meet. Suppl., Abstract V22D-08, 2001.

421. S. L. Brantley, A. D. Anbar, R. Guynn, J. Barling, L. Liermann, G. Icopini (2001). Fe release and isotopic fractionation during dissolution of hornblende and goethite in the presence of soil bacteria. *Eos Trans. AGU* ***82***, Fall Meet. Suppl., Abstract V21A-0970, 2001.

422. A. Saha, A. R. Basu, J. Barling, A. D. Anbar, P. R. Hooper (2001). Hf-Nd isotopic correlation in the Deccan Flood Basalt Province. *Eos Trans. AGU* ***82***, Fall Meet. Suppl., Abstract V52B-05, 2001.

423. R. Buick, A. D. Anbar, S. J. Mojzsis, A. J. Kaufman, T. L. Kieft, T. W. Lyons and M. Humayun (2001). The case for scientific drilling of Precambrian sedimentary sequences: A mission to early Earth. *Eos Trans. AGU* ***82***, Fall Meet. Suppl., Abstract P22B-0544, 2001.

424. A. D. Anbar, R. Buick, S. J. Mojzsis, A. J. Kaufman, T. L. Kieft, T. W. Lyons and M. Humayun (2001). The case for scientific drilling of precambrian sedimentary sequences: A mission to early Earth. *2001 Meeting of the Geological Society of America,* Boston, MA.

425. *G. L. Arnold, J. Barling and A. D. Anbar (2001). Molybdenum stable isotopes: A potential new tool for quantifying the extent of bottom water anoxia. *2001 Meeting of the Geological Society of America,* Boston, MA.

426. *J. E. Roe, A. D. Anbar and J. Barling (2001). Mechanisms of nonbiological fractionation of Fe isotopes. *Applied Isotope Geochemistry IV (2001),* Pacific Grove, CA

427. *J. E. Roe, A. D. Anbar and J. Barling (2001). Mechanisms of nonbiological fractionation of Fe isotopes. *European Union of Geosciences XI (2001),* Strasbourg, France.

428. A. D. Anbar, K. J. Zahnle, G. L. Arnold and S. J. Mojzsis (2000). Extraterrestrial iridium, sediment accumulation and the habitability of the earth Earth. *2000 American Geophysical Union Fall Meeting,* San Francisco, CA **Invited**.

429. *M. L. Polizzotto, M. Sharma and A. D. Anbar (2000). Fe isotopes in deep-sea hydrothermal fluids. *2000 American Geophysical Union Fall Meeting,* San Francisco, CA

430. *E. S. Holman and A. D. Anbar (2000). Modeling equilibrium isotope fractionations of transition metal complexes and metal-bearing biomolecules. *2000 American Geophysical Union Fall Meeting,* San Francisco, CA

431. A. D. Anbar, G. L. Arnold and J. Barling (2000). Molybdenum isotopes: Potential paleoredox probes? *2000 American Geophysical Union Fall Meeting,* San Francisco, CA

432. #J. Barling, G. Ravizza, C. Tuit and A. D. Anbar (2000). Fractionation of molybdenum isotopes in Black Sea sediments. *2000 American Geophysical Union Spring Meeting,* Washington, D.C.

433. A. D. Anbar, J. E. Roe, E. S. Holman, J. Barling and C. Zhang (1999). Biotic and abiotic fractionations of iron isotopes. *1999 American Geophysical Union Fall Meeting,* San Francisco, CA

434. A. D. Anbar and A. H. Knoll (1999). Trace Metal Limitation of Primary Production 1.85-1.25 Ga. *1999 American Geophysical Union Fall Meeting,* San Francisco, CA **Invited**.

435. A. R. Basu, J. Barling, A. A. Smith, A. D. Anbar, and R. J. Poreda (1999). Hf, Nd, Sr, and He Isotopes in Alkali Igneous Complexes of the Deccan: Implications for the Plume Source. *1999 American Geophysical Union Fall Meeting,* San Francisco, CA

436. A. D. Anbar, K. A. Knab, J. Barling and J. E. Roe (1999). Fractionation of transition metal stable isotopes: Toward the development of new biogeochemical tracers. *1999 Meeting of the Geological Society of America,* Denver, CO. **Invited**.

437. A. D. Anbar, C. Zhang, J. Barling, J. E. Roe and K. H. Nealson (1999). Iron isotope fractionation studies using MC-ICP-MS. *9th V. M. Goldschmidt Conference,* Cambridge, MA.

438. A. D. Anbar, G. L. Arnold, S. J. Mojzsis and K. J. Zahnle (1999). The extraterrestrial mass flux on the early Earth. *9th V. M. Goldschmidt Conference,* Cambridge, MA. **Invited**.

439. A. D. Anbar, J. Barling and J. E. Roe (1998). Application of Cu and Mo isotope fractionations to the study of life in extreme environments. *1998 American Geophysical Union Fall Meeting,* San Francisco, CA

440. A. G. Morgan, Y. L. Yung, M. Allen, M. Carr, D. Halpern and A. D. Anbar (1998). Methyl bromide: Sources and sinks in the ocean and land. *1998 American Geophysical Union Fall Meeting, San Francisco,* CA

441. *G. L. Arnold, A. D. Anbar and S. J. Mojzsis (1998). Iridium and platinum in early Archean metasediments: Implications for sedimentation rate and the extraterrestrial flux. *1998 Meeting of the Geological Society of America,* Toronto, Canada.

442. A. D. Anbar, J. Barling and J. E. Roe (1998). Determination of Cu and Mo isotope fractionations in natural materials using MC-IPC-MS. *8th V. M. Goldschmidt Conference,* Toulouse, France.

443. A. D. Anbar, J. Barling and J. Roe (1998). Study of Transition Metal Isotope Fractionations by MC-ICP-MS. *1998 American Geophysical Union Spring Meeting,* Boston, MA.

444. A. D. Anbar and G. J. Wasserburg (1997). Iridium in the Oceans. *7th V. M. Goldschmidt Conference,* Tucson, AZ.

445. A. D. Anbar, D. A. Papanastassiou, and G. J. Wasserburg (1996). Iridium in natural waters. *1996 American Geophysical Union Spring Meeting,* Baltimore, MD.

446. A. D. Anbar, D. A. Papanastassiou, R. A. Creaser, and G. J. Wasserburg (1994). Iridium in seawater: First observations. *1994 American Geophysical Union Spring Meeting,* Baltimore, MD.

447. Y. L. Yung and A. D. Anbar (1994). Marine CH_3Br: The effect of temperature on the ocean-atmosphere flux. *1994 American Geophysical Union Spring Meeting,* Baltimore, MD.

448. A. D. Anbar, R. A. Creaser, D. A. Papanastassiou, and G. J. Wasserburg (1992). Rhenium in seawater: Confirmation of generally conservative behavior. *1992 American Geophysical Union Fall Meeting,* San Francisco, CA

449. A. D. Anbar, M. Allen. M-T. Leu, H. A. Nair and Y. L. Yung (1992). The impact of temperature dependent CO_2 cross section measurements: a role for heterogeneous chemistry in the atmosphere of Mars? *1992 Conference on Mars Surface and Atmosphere Through Time (MSATT),* Kona, HI.

450. A. D. Anbar, M-T. Leu and Y. L. Yung (1991). Adsorption of HO_x on surfaces in the atmosphere of Mars. *1991 Conference of the Division of Planetary Science of the Astronomical Society,* San Francisco, CA

451. M-T. Leu, J. Blamont, A. D. Anbar, L. F. Keyser and S. P. Sander (1991). Sticking coefficients of CO on aerosols; implications for the Martian atmosphere. *1991 American Geophysical Union Spring Meeting,* Baltimore, MD.

452. A. D. Anbar, G. A. Blake, and G. R. Rossman (1990). Nonlinear spectroscopy of silicate minerals: Hole-burning in muscovite. *1990 Pacific Conference on Chemistry and Spectroscopy,* San Francisco, CA

Invited Presentations/Colloquia

1. *To Breathe or Not to Breathe? Exoplanet Mantles May Answer the Question.* Colloquium, Department of Earth, Planetary, and Space Sciences, UCLA, May, 2026.

2. *Arsenic and the Art of Scientific Debate*, Colloquium, School of Earth and Space Exploration, Arizona State University, February, 2026.

3. *Arsenic and the Art of Scientific Debate*, SAMBA Group, Arizona State University, December, 2025.

4. *Arsenic and the Art of Scientific Debate*, Biophysics Lunch Seminar, SUNY at Buffalo, October, 2025.

5. *REAL CHEM.* Panel presenter and presentation producers at the 25th Anniversary of the Gates Foundation, Seattle, WA, May, 2025.

6. *Are We Alone?* Four Seasons Seminar, Emeritus College, Arizona State University, December, 2024.

7. *Redox Revolutions: Ancient Earth and Beyond.* Department of Earth, Atmosphere, and Environment, Northern Illinois University, September, 2024 (AGU Distinguished Lecture Series).

8. *The Science of Living Worlds.* Systems Ecology Seminar Series, University of Montana, February, 2024.

9. *Educating Through Exploration: Raising the Bar on OER*. Kean University OER Conference Keynote, April, 2023.

10. *The Science of Living Worlds.* School of Marine Science and Policy, University of Delaware, September, 2023 (AGU Distinguished Lecture Series).

11. *The Science of Living Worlds.* Earth Weeks Public Lecture, School of Oceanography, University of Washington, April 2023.

12. *Molybdenum in Space and Time.* MoTEC (Molybdenum and Tungsten Enzymes Conference), October 2022.

13. *Redox Revolutions: Earth and Beyond.* Woods Hole Oceanographic Institution, September, 2022.

14. *Biogeochemistry and Evolution.* CIDER Summer School 2022, July, 2022.

15. *Earth's Evolution as an Inhabited World: Overview of Questions and Challenges.* CIDER Summer School, June, 2022.

16. *Equity Through Exploration.* ASU REMOTE, Online Symposium, June, 2022.

17. *Looking for Life on Other Worlds: A Biogeochemical Perspective.* Italian Geological Society, Online Symposium on Geobiology and Society, November, 2021.

18. *Life on Earth: Past, Present, and Future.* Biology Colloquium, Rhode Island College, October, 2021.

19. *Educating Through Exploration.* The Remote Summit, Online Symposium, June, 2021.

20. *Redox Revolutions: Earth and Beyond.* Research School of Earth Sciences, Australia National University, Canberra, Australia, May, 2021.

21. *Educating Through Exploration.* RemoteK12, Online Symposium, January, 2021.

22. *Redox Revolutions: Earth and Beyond.* Jet Propulsion Laboratory, Caltech, January, 2021.

23. *Redox Revolutions: Earth and Beyond.* Institute Earth Sciences, Hebrew University, December, 2020.

24. *Redox Revolutions: Earth and Beyond.* Institute of Surface-Earth System Science, Tianjin University, November, 2020.

25. *Redox Revolutions: Earth and Beyond.* Department of Geological Sciences, University of North Carolina – Chapel Hill, August, 2020.

26. *Education Through Exploration: Reimagining Learning in a Digital Age*. UNSW Education Focused Retreat, Sydney, Australia, August, 2020.

27. *Education Through Exploration: Reimagining Learning in a Digital Age*. The Remote Summit, Online Symposium, July, 2020.

28. *Redox Revolutions: Earth and Beyond.* Jackson School of Geosciences, University of Texas – Austin, February, 2020.

29. *Medical Metallomics: Can Calcium Isotopes Detect Cancer?* Department of Physics, University of Texas – Austin, February, 2020.

30. *Redox Revolutions.* Lunar and Planetary Laboratory, University of Arizona, October, 2019.

31. *Education Through Exploration: Reimagining Learning in a Digital Age*. Kiwanis Club of Tempe, September, 2018.

32. *Education Through Exploration: A New Model of Learning Design.* Learning Innovation Summit, NASA Ames Research Center, June, 2018.

33. *Education Through Exploration: Reimagining Learning in a Digital Age*. Pennsylvania State University, April, 2018 (B. Willard and Ruby S. Miller Lectureship in Geography).

34. *Education Through Exploration: Reimagining Learning in a Digital Age*. Rotary Club of Tempe, March, 2018.

35. *Life on Earth and Beyond: Past, Present, and Future*. Aerobics for the Mind, Gold Canyon, March, 2018.

36. *Elements and Evolution.* Gordon Research Conference on Metals in Biology, Ventura, CA, January, 2018.

37. *A New Teaching Approach: Education Through Exploration.* Learning Innovation Summit, Melbourne, Australia, July, 2017.

38. *Designing an Integrated Theory of Earth Evolution.* University of Washington seminar hosted by the NAI Virtual Planetary Lab, Seattle, WA, May, 2017.

39. *Education Through eXploration: Reimagining Learning in a Digital Age.* Oregon State University "Innovating Science Online" lecture, Corvallis, OR, March, 2017.

40. *Evolutionary Metallomics.* Pittcon, Chicago, March, 2017.

41. *Reimagining Education in a Digital Age.* AAC&U Annual Meeting, January, 2016.

42. *Reimagining Education in a Digital Age.* Keynote presentation, Grand Opening of the Center for Excellence in Teaching and Learning, Georgia State University, April, 2016.

43. *Life on Earth and Beyond: Past, Present, and Future*. New Discoveries lecture series, School of Earth & Space Exploration, Arizona State University, April, 2016.

44. *Redox Revolutions.* CIDER presentation, May 2016 (presentation cancelled due to conflict).

45. *Transdisciplinary Training through Technology*. EarthCube keynote, July, 2016.

46. *The Emergence of a Planetary Intelligence.* Coffee@Beyond Seminar, September, 2016.

47. *Redox Revolutions.* Dept. of Earth, Planetary, and Atmospheric Sciences, Massachusetts Institute of Technology, Cambridge, MA, April, 2016.

48. *Good Golly, It's Moly!* MSA Short Course on Nontraditional Stable Isotopes, Berkeley, CA, December, 2016.

49. *Improving Student Success with Digital Learning in Higher Education.* U.S. Education Learning Forum, Bill & Melinda Gates Foundation, October, 2015.

50. *Reimagining Science Education in the Digital Age: Education through Exploration.* DREAM 2015, February 2015.

51. *The Breath of Life: Oxygen in Earth's Atmosphere and the Search for Life Beyond.* Sigma Xi (ASU), October, 2015.

52. *Education Through Exploration.* Department of Earth Sciences, University of Toronto, Toronto, Canada, February, 2015.

53. *A Non-Traditional Application of Non-Traditional Isotopes: Can Calcium Isotopes Detect Cancer?* Department of Earth Sciences, University of Toronto, Toronto, Canada, February, 2015.

54. *Education Through Exploration.* Department of Geological Sciences, Indiana University, February, 2015.

55. *A Non-Traditional Application of Non-Traditional Isotopes: Can Calcium Isotopes Detect Cancer?* Department of Geological Sciences, Indiana University, February, 2015.

56. *Virtual Exploration of Earth's Evolution.* Spirit of the Senses (Phoenix community group), September, 2014.

57. *Detecting Exoplanetary Ecosystems.* Invited plenary talk at the 3rd International Geobiology Conference, Wuhan, China, June 2014.

58. *A Non-Traditional Application of Non-Traditional Isotopes: Can Calcium Isotopes Detect Cancer?* Chinese Academy of Geological Sciences, Beijing, June, 2014.

59. *A Non-Traditional Application of Non-Traditional Isotopes: Can Calcium Isotopes Detect Cancer?* University of Science and Technology of China, Hefei, June, 2014.

60. *The Uranium Isotope Paleoredox Proxy: A Primer and Future Prospects.* University of Science and Technology of China, Hefei, June, 2014.

61. *Are We Alone?* Invited presentation to the ASU Faculty Emeritii Association, April, 2014.

62. *Early Detection of Osteolytic Lesions in Multiple Myeloma using Natural Calcium Isotopes.* Dept. of Earth and Planetary Sciences, University of New Mexico, September, 2013.

63. *Astrobiology.* 100 Year Starship Symposium, September, 2013.

64. *A Whiff of Oxygen in the Anoxic Archean.* Astrobiology Lecture Series, Rensselear Polytechnic Institute, May, 2013.

65. *Metallomic Markers in Medicine.* ASU Biodesign Program Presentation, April, 2013.

66. *ASU and OpenClass: Are We Alone? Teaching Science Through Exploration.* Cite 2013 Conference, Chicago, IL, April, 2013

67. *Metal Stable Isotopes as Environmental Source Tracers: Fe & Hg Isotope Case Studies.* Dept. of Soil, Water and Environmental Science, University of Arizona, March, 2013.

68. *Looking at Earth from a Different Perspective.* Tempe Chamber of Commerce Hot Topics and Lunch, Tempe, AZ, February, 2013. (http://azscitechfest.org/node/1545)

69. *The Great Poisoning: How Oxygen Transformed our Planet.* Beyond workshop on Oxygen and Cancer, Scottsdale, AZ, November, 2012.

70. *Astrobiology at ASU.* Tempe South Rotary Club, Tempe. AZ, November, 2012.

71. *Habitable Worlds: A HiFi Online Course.* Presentation with Adrian Sannier (Pearson) at EDUCAUSE, Denver, CO, October, 2012.

72. *Extracting Features of the History of Life on Earth from the Geologic Record.* Guest Lecture (video), Montana State University Astrobiology Course, October, 2012.

73. *Flipping to Avoid Flopping: Inverting the Lecture-Lab Paradigm.* Keynote presentation at Adaptive eLearning Forum, University of New South Wales, Sydney, Australia, July 2012.

74. *Calcium Isotope Biomarkers in Biomedicine and Human Space Exploration.* Dept. of Earth & Space Sciences, University of California – Los Angeles, May, 2012.

75. *Catalyzing Creative Connections.* Keynote presentation at Sustainability Symposium, School of Environmental Studies, The Hebrew University of Jerusalem, Israel, May, 2012.

76. *Driving Digital Disruption: How I learned to stop worrying and embrace online education.* Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel, May, 2012.

77. *Every Breath You Take: An Early Whiff of Oxygen on the Ancient Earth.* Interuniversity Institute for Marine Sciences, Eilat, Israel, April, 2012.

78. *Paleoredox Proxies: Molybdenum and Uranium Isotopes.* 4th Kaplan Symposium, Ein Gedi, Israel, March, 2012.

79. *A Whiff of Oxygen in the Anoxic Archean.* Dept. of Geological Sciences, Ben Gurion University, Beer-Sheba, Israel, March, 2012.

80. *A Whiff of Oxygen in the Anoxic Archean.* Dept. of Environmental Sciences, Weizmann Institute of Science, Rehovot, Israel, March, 2012.

81. *Calcium Isotope Biomarkers in Biomedicine and Human Space Exploration.* Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel, March, 2012.

82. *Oxygen Evolution: Scratching the Surface.* Keynote presentation at NERC Workshop on Volatiles and Fluids, Oxford, UK, February, 2012.

83. *Putting the "Geo" in Astrobiology.* Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel, February, 2012.

84. *A Whiff of Oxygen in the Anoxic Archean.* Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel, January, 2012.

85. *Origins of Life: Earth and Beyond.* ASU President's Community Engagement Program, Scottsdale, AZ, February, 2011.

86. *An Early Whiff of Oxygen.* Origins Workshop, ASU Origins Project, Tempe, AZ, March, 2011.

87. *Calcium Isotopes in Biomedicine and Human Space Exploration.* School of Earth & Space Exploration Colloquium, Arizona State University, February, 2011.

88. *NASA, Astrobiology and Continental Scientific Drilling: The Astrobiology Drilling Program.* DOSECC Workshop, Washington, DC, May, 2011.

89. *Isotopic Inferences.* Guest Lecture (video), Montana State University Astrobiology Course, October, 2011.

90. *Follow the Elements: An Early Whiff of Oxygen?* Dept. of Geosciences, Lawrence Livermore National Laboratory, Livermore, CA, December, 2010.

91. *Follow the Elements: An Early Whiff of Oxygen?* Space Telescope Science Institute, Baltimore, MD, October, 2010.

92. *Follow the Elements: An Early Whiff of Oxygen?* Dept. of Geosciences, Pennsylvania State University, State College, PA, October, 2010.

93. *Nutrients and Trace Elements through Time.* NAI Anaerobic Photosynthetic Ecosystems Workshop, Fayetteville, NY, October, 2010.

94. *Follow the Water?* Scottsdale Museum of Contemporary Art, Scottsdale, AZ, September, 2010.

95. *Deep Time Drilling as a Window into Earth's Early History.* NSF Workshop, Carnegie Institute of Washington, Washington, DC, August, 2010.

96. *Drilling Deep Time: Windows into Earth's Early Biosphere.* NSF Headquarters, Washington, DC, July, 2010.

97. *The Early Breath of Life: Evidence of O_2 in the Late Archean Eon.* Australian Centre for Astrobiology, University of New South Wales, Sydney, Australia, April, 2010.

98. *Photosynthesis and the rise of O_2: constraints from the geologic record.* 19th Western Photosynthesis Conference, Pacific Grove, CA, January, 2010.

99. *Searching for Life at ASU.* Spirit of the Senses (Phoenix community group). October, 2009.

100. *Follow the Elements: Astrobiology at ASU.* Canada Institute for Advanced Research (CIFAR) workshop on astrobiology, Toronto, Canada, April, 2009.

101. *Follow the Elements: Astrobiology at ASU.* NASA Astrobiology Institute Team Overview Seminar, Videocon broadcast, March, 2009.
http://nai.arc.nasa.gov/library/uploads/AB090316.mov

102. *Elements and Evolution.* School of Life Sciences Seminar Series, Arizona State University, Tempe, AZ, April, 2009.

103. *Follow the Elements: Astrobiology at ASU.* School of Earth & Space Exploration Colloquium, Tempe, AZ, January, 2009.

104. *Science & Technology Education: The University of Tomorrow?* Presentation to the American Technion Society, September, 2008.

105. *The Origin of the Earth.* Temple Emmanuel (Tempe) Science & Religion Event, May, 2008.

106. *Alternative Earths.* Presentation in the *Final Word* symposium series, ASU Kerr Cultural Center, February, 2008.

107. *Alternative Earths.* Presentation to the Humanist Society of Greater Phoenix, February, 2008.

108. *Life in the Universe: Lessons from a Dead World.* Invited presentation to the ASX Symposium "Expanding Canada's Frontiers: Lunar Exploration", Toronto, Canada, January, 2008.

109. *A Whiff of Oxygen before the Great Oxidation Event?* Department of Geological Sciences, University of Toronto, Toronto, Canada, January, 2008.

110. *A Whiff of Oxygen before the Great Oxidation Event?* NASA Astrobiology Institute Director's Seminar Series, Videocon broadcast, November, 2007.
http://nai.arc.nasa.gov/seminars/seminar_detail.cfm?ID=112

111. *A Whiff of Oxygen before the Great Oxidation Event?* Astrobiology Seminar Series, University of Arizona, Tucson, AZ, November, 2007.

112. *Evidence for a Whiff of Oxygen before the Paleoproterozoic Great Oxidation Event.* Department of Geological Sciences, University of Michigan, Ann Arbor, MI, October, 2007.

113. *A Whiff of Oxygen before the Great Oxidation Event?* NASA Astrobiology Institute Biosignatures Workshop, Sudbury, ON, Canada, September, 2007.

114. *An Early Whiff of Oxygen and a Late Stench of Sulfide?* Department of Earth & Space Sciences, University of California, Los Angeles, May, 2007.

115. *Insights into Ocean Redox Evolution from Metals and Metal Isotopes.* Department of Geology, University of Texas, El Paso, TX, April, 2007.

116. *A Whiff of Oxygen before the Great Oxidation Event?* Department of Geoscience, University of Nevada, Los Vegas, NV, March, 2007.

117. *A Whiff of Oxygen at the Archean-Proterozoic Boundary.* School of Earth & Space Exploration Colloquium, Tempe, AZ, February, 2007.

118. *A Whiff of Oxygen at the Archean-Proterozoic Boundary.* Department of Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, January, 2007.

119. *A Whiff of Oxygen before the Great Oxidation Event.* Department of Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, January, 2007.

120. *Alternative Life: Let's Get Elemental!* Alternative Life Workshop, ASU, December, 2006.

121. *Redox Revelations: An Early Whiff of Oxygen and a Late Stench of Sulfide?* Department of Geological and Environmental Sciences, Stanford, November, 2006.

122. *Alternative Earths.* Astrobiology Lecture Series, New Mexico Institute of Technology, October, 2006.

123. *Oxygenation of the Surface Ocean at the Archean-Proterozoic Boundary.* Astrobiology Class Lecture, New Mexico Institute of Technology, October, 2006.

124. *Drilling in Western Australia: Progress and Prospects.* Agouron Foundation Drilling Workshop, Pasadena, CA, October, 2006.

125. *The Earth through Time: The Earth's Coevolution with the Biosphere.* Pale Blue Dot III, Chicago, IL, September, 2006.

126. *The Evolution of the Earth*. Spirit of the Senses (Phoenix community group), September, 2006.

127. *Follow the Elements!* Gordon Research Conference on the Origin of Life, Lewiston, ME. July, 2006.

128. *"Non-traditional" Isotopic Biosignatures.* NRC Biosignature Workshop, Washington, DC, May, 2006.

129. *The Rise of Oxygen and the Evolution of the Metallome.* Agouron Foundation O2 Workshop, Santa Fe, NM, April, 2006.

130. *Hot Night in the City? The Present, Past and Future of Earth's Climate System*. The Last Lecture Series, Arizona State University, Tempe, AZ, April, 2006.

131. *Insights into Ocean Redox Evolution from Metals and Metal Isotopes.* Scripps Institute of Oceanography, March 2006.

132. *Molybdenum Isotopes as Paleoredox Proxies.* NSF Workshop on Paleoproxies, San Francisco, CA December, 2005.

133. *Good Golly, It's Moly! Insights into the Evolution of Life and Environment from Molybdenum, Mass Spectrometry and Metallomics.* Department of Chemistry, Northern Arizona University. October, 2005.

134. *Transition Metal Stable Isotopes.* 1st I. R. Kaplan Workshop: New Developments in Environmental Isotope Research, Hagoshrim, Israel. September, 2005.

135. *Insights into Redox Evolution of the Oceans from Molybdenum and Iron Isotopes.* 1st I. R. Kaplan Workshop: New Developments in Environmental Isotope Research, Hagoshrim, Israel, September, 2005.

136. *Environmental Geochemistry of Novel Stable Isotopes: Systematics, Surprises and Solutions.* Environmnetal Bioinorganic Chemistry Group, Princeton University, April, 2005.

137. *Good Golly, It's Moly! Insights into the Evolution of Life and Environment from Molybdenum, Mass Spectrometry and Metallomics.* Department of Chemistry, Bryn Mawr College. April, 2005.

138. *Testimony before the President's Commission on Implementation of U.S. Space Exploration Policy.* Public Hearing, May, 2004.

139. *Molybdenum Stable Isotopes: Observation, Interpretations and Directions.* MSA Short Course on the Geochemistry of Non-traditional Stable Isotopes, Montreal, Canada, May, 2004.

140. *Microbes and Metal Isotopes: Building a Bioinorganic Bridge.* Gordon Research Conference on Environmental Bioinorganic Chemistry, Bates College, NH, July, 2004.

141. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Department of Earth and Space Sciences, University of Washington. October, 2003.

142. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Agouron-Wrigley-USC Geobiology Summer Course, the Wrigley-USC Institute for Environmental Studies, Catalina Island, CA July, 2003.

143. *Molybdenum Isotopes in Biology and the Environment.* Gordon Research Conference on Molybdenum and Tungsten Enzymes, Meridan, NH. June, 2003.

144. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Department of Geophysical Sciences, University of Chicago. June, 2003.

145. *Microbes and Metal Isotopes: Building a Bioinorganic Bridge.* Department of Geology, Arizona State University. May, 2003.

146. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Department of Geosciences, Princeton University. March, 2003.

147. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Department of Earth and Atmospheric Sciences. Cornell University. March, 2003.

148. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* Department of Geology, Arizona State University. February, 2003.

149. *Good Golly, It's Moly! Insights into Ocean Chemistry and Evolution from Molybdenum and its Isotopes.* USGS- Menlo Park. February, 2003.

150. *Stable Isotope Geochemistry of Transition Metals: Methods, Mechanisms and the need for Models.* Department of Geosciences, Princeton University. December, 2002.

151. *In Pursuit of Proterozoic Paleoredox: Insight from Molybdenum Isotopes.* Center for Astrobiology, University of Colorado (Boulder). October, 2002.

152. *Proterozoic Ocean Chemistry and Evolution: A Bioinorganic Bridge?* Department of Chemistry, University of Cincinnati. October, 2002.

153. *Molybdenum Isotopes: In Pursuit of Proterozoic Paleoredox.* New York Center for Studies on the Origins of Life, Rensselaer Polytechnic Institute. September, 2002.

154. *Ocean Chemistry & Evolution: Insight from Molybdenum and its Isotopes.* Dept. of Chemistry, University of Rochester. September, 2002.

155. *Molybdenum Isotopes: In Pursuit of Proterozoic Paleoredox.* Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology. April, 2002.

156. *Novel Isotopic Biosignatures: Promise and Progress.* NAI Director's Seminar Series Webcast. March, 2002.

157. *Novel Isotopic Biosignatures: Promise and Progress.* Gordon Research Conference on the Origin of Life, Ventura, CA January, 2002.

158. *Earth, Mars and Beyond: The Search for Life in Difficult Places.* Kodak Research & Engineering Retirees Organization, Rochester, NY. January, 2002.

159. *Iron Isotopes and the Search for Life on Mars.* Department of Chemistry, Alfred College, October, 2001.

160. *Iron Isotopes and the Search for Life on Mars.* Department of Chemistry, SUNY Brockport. September, 2001.

161. *Earth, Mars and Beyond: The Search for Life in Difficult Places.* University of Rochester Alumni Association. September, 2001.

162. *Transition Metal Isotope Fractionation: Promise and Progress.* Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology. September, 2001.

163. *Transition Metal Isotope Fractionation: Promise and Progress.* Gordon Research Conference on Chemical Oceanography, Tilton, NH. August, 2001.

164. *Mission to Early Earth: Overview.* 2001 Meeting of the NASA Astrobiology Institute, Carnegie Institution of Washington. April, 2001.

165. *Iron Isotopes and the Search for Life on Mars: Promise and Progress.* Department of Geology and Geophysics, University of Minnesota. March, 2001.

166. *Molybdenum Isotopes: Potential Paleoredox Probes?* Department of Geology and Geophysics, University of Minnesota. March, 2001.

167. *Iron Isotopes and the Search for Life on Mars: Promise and Progress.* Department of Geological Sciences, University of Missouri. January, 2001.

168. *Iron Isotopes and the Search for Life on Mars: Promise and Progress.* Department of Geology, Arizona State University. October, 2000.

169. *Iron Isotopes and the Search for Life on Mars: Promise and Progress.* Department of Earth Sciences, Syracuse University. September, 2000.

170. *Iron Isotopes and the Search for Life on Mars.* Department of Chemistry, SUNY Geneseo. September, 2000.

171. *Iron Isotopes: Promise and Progress.* Department of Geophysical Sciences, University of Chicago. May, 2000.

172. *Iron Isotopes: Biomarker Prospects.* NRC Workshop on Life Detection (Committee on the Origin and Evolution of Life of the NAS Space Studies Board and Board on Biology), Carnegie Institution of Washington. April, 2000.

173. *Fractionations of Transition Metal Stable Isotopes: Promise and Progress.* Geochemical Perspectives on Environmental Processes – 2000, Washington University. April 2000.

174. *Stable Isotope Geochemistry of Transition Metals: Iron Isotope Inferences.* Department of Geological Sciences, Cornell University. March, 2000.

175. *Stable Isotope Geochemistry of Transition Metals: Iron Isotope Inferences.* Department of Geosciences, Pennsylvania State University. March, 2000.

176. *The Search for Life: Inferences from Iron Isotopes?* Dept. of Physics, University of Rochester. January, 2000.

177. *Stable Isotope Geochemistry of Transition Metals: Iron Isotope Inferences.* Division of Geological and Planetary Sciences, California Institute of Technology. December, 1999.

178. *Life in the Geologic Record: Inferences from Iron Isotopes?* Department of Geology and Geophysics, Yale University. October, 1999.

179. *The Search for Life in Far-off Places.* Laboratory for Laser Energetics, University of Rochester. September, 1999.

180. *The Extraterrestrial Mass Flux on the Early Earth: Implications for Life.* Department of Geology and Geophysics, Yale University. April, 1999.

181. *Determination of Cu and Mo Isotope Fractionations Using MC-ICP-MS (poster w/J. Barling and J. E. Roe)*. Gordon Research Conference on Chemical Oceanography, Barga, Italy. May, 1998.

182. *Trace Element Frontiers.* Dept. of Earth and Atmospheric Sciences, University of Alberta. January, 1998.

183. *Fractionation of transition metal stable isotopes: A new approach for the study of life in the geologic record (poster w/J. Barling, J. E. Roe, K. A. Knab and K. Nealson).* Gordon Research Conference on the Origin of Life, Ventura, CA February, 1999.

184. *The Environmental Chemistry of Iridium: Providing Perspective on Dinosaur Doom.* Department of Chemistry, Canisius College. February, 1997.

185. *Trace Element Frontiers.* Dept. of Earth and Planetary Sciences, Harvard University. December, 1996.

186. *The Environmental Chemistry of Iridium: Providing Perspective on Dinosaur Doom.* Meeting of the W. New York Section of the American Chemical Society. November, 1996.

187. *Iridium in Natural Waters.* Dept. of Geology, Woods Hole Oceanographic Institution. August, 1996.

188. *Iridium in Natural Waters.* Dept. of Earth and Planetary Sciences, Harvard University. May, 1996.

189. *Iridium in Natural Waters.* Dartmouth College, Department of Earth Sciences. May, 1996.

190. *The Photochemistry of Manganese and the Origin of Banded Iron Formations (poster w/H. D. Holland)* Gordon Research Conference on the Origins of Life, Concord, NH. August, 1990.

Funding History

Active Awards:

Source of Support: NASA SMD
Principal Investigator: A. D. Anbar (originally L. Elkins-Tanton)
Co-Investigators: S. Semken and other SESE faculty
Project Title: NASA SMD Exploration Connection (the Infiniscope Project)
Award Amount: $10,183,479 (2/1/16 – 1/31/21); $10,780,742 (2/1/21 – 1/31/26)
Period of Award: 2/1/16 – 12/31/26 (granted no-cost extension)

Source of Support: Bill & Melinda Gates Foundation
Principal Investigator: A. D. Anbar
Title: ASU CMU Real Chem 2 Courseware Phase 2
Award Amount: $1,490,024
Period of Award: 1/1/26 – 12/31/27

Source of Support: Bill & Melinda Gates Foundation
Principal Investigator: A. D. Anbar
Title: 2021 Courseware Second Exemplar - NSE - ASU/CMU
Award Amount: $3,988,558 + $2,500,000
Period of Award: 11/23/21 – 1/31/26

Source of Support: NASA ICAR
Principal Investigator: Betül Kaçar (U. Wisconsin)
Co-Investigators: A. D. Anbar (Deputy PI) and multiple other Co-Is
Project Title: What Life wants: Exploring the Natural Selection of Elements
Award Amount: $1,782,724 to ASU
Period of Award: 10/31/20 – 9/30/26

Source of Support: NSF
Principal Investigator: A. D. Anbar (collaborative proposal led by Jonathan Payne at Stanford)
Project Title: Collaborative Research: Testing the reduction of aerobic habitat as a common kill mechanism for major mass extinction events
Award Amount: $231,457
Period of Award: 9/1/21 – 8/31/26

Source of Support: NASA Exobiology
Principal Investigator: A. D. Anbar
Project Title: Refining the Geochemical Toolkit
Award Amount: $704,133 + $150,000 instrumentation supplement
Period of Award: 2/13/19 - 12/12/26 (granted no-cost extension)

Source of Support: NASA SMD

Principal Investigator: M. Wadhwa (ASU)
Co-Investigators: A. Anbar and other SESE faculty
Project Title: NASA SMD Community of Practice for Education (SCoPE)
Award Amount: $4,965,390
Period of Award: 2/1/21 – 12/31/26 (granted no-cost extension)

Source of Support: NSF
Principal Investigator: C. Mead (ASU)
Co-Investigators: A. Anbar (ASU); D. Huntzinger (NAU; project lead)
Title: EHR-Polar DCL: Collaborative: Polar Explorer - A Virtual Learning Environment for Polar Science Education
Award Amount: $644,692
Period of Award: 7/15/21 - 6/30/26

Source of Support: NASA Human Research Program
Principal Investigator: G. Gordon (ASU)
Co-Investigator: A. D. Anbar
Project Title: Evaluating Resistive Exercise As A Long-Term Countermeasure For Spaceflight-Induced Bone Loss Using Calcium Isotopes exposure (CIPHER Study)
Award Amount: $1,003,260
Period of Award: 4/11/22 - 4/10/35

Source of Award: US Department of Education
Principal Investigator: D. McNamara (ASU)
Co-Investigators: A. D. Anbar, R. Roscoe, B. Weigle
Project Title: The ASU Learning at Scale Digital Learning Network
Award Amount: $2,000,000
Period of Award: 9/1/21 - 8/31/26

Pending Awards:

Source of Award: Battelle/NSF
Principal Investigator: P. Schlosser
Co-Investigators: A. D. Anbar and other ASU researchers
Project Title: Battelle - National Ecological Observatory Network (NEON)
Total Amount: $16,883,863
Period of Award: 11/1/23 - 10/31/28

Expired Awards:

Source of Support: Howard Hughes Medical Institute
Principal Investigator: J. Collins (ASU)
Co-Investigators: A. D. Anbar, S. Brownell
Project Title: Teaching transformed: Using education technology to create a culture of inclusive excellence
Award Amount: $1,000,000

Period of Award: 9/1/18 – 8/31/25

Source of Support: NSF
Principal Investigator: M. Simon (ASU)
Co-Investigators: A. Anbar and C. Mead
Title: Bringing authentic research to the remote classroom: The first fully online Course-based Undergraduate Research Experience (CURE) for Astronomy majors
Award Amount: $299,840
Period of Award: 10/1/21 - 9/30/25

Source of Support: NSF
Principal Investigator: A. D. Anbar
Co-Investigators: W. Zheng (now at Tianjin University, China, so technically not a Co-PI)
Project Title: Mercury Stable Isotopes as a Proxy of Photic Zone Euxinia
Award Amount: $420,380
Period of Award: 6/1/20 – 5/31/25

Source of Support: U.S. Dept. of Education
Principal Investigator: A. D. Anbar
Project Title: Consortium for Open Active Pathways
Award Amount: $2,500,000
Period of Award: 3/1/19 – 2/28/24

Source of Support: Howard Hughes Medical Institute
Principal Investigator: A. D. Anbar
Co-Investigators: None
Project Title: Virtual Exploration of Earth's Evolution
Award Amount: $1,000,000
Period of Award: 9/1/14 – 8/31/22

Source of Support: Future Investigators in NASA Earth and Space Science and Technology
Principal Investigator: A. D. Anbar (with D. Sullivan, graduate student)
Project Title: NESSF: Bridging the O_2 Gap: Using Rhenium Isotopes to Detect Low O_2 in Ancient Oceans
Award Amount: $120,000
Period of Award: 9/1/20 – 8/31/23

Source of Support: NSF
Principal Investigator: K. Borner (Indiana University)
Project Title: Analytics-Driven Accessible Pathways To Impacts-Validated Education (ADAPTIVE)
Award Amount: $200,000 to ASU
Period of Award: 9/1/19 – 5/31/21

Source of Support: NASA - Earth and Space Science Fellowship
Principal Investigator: A. D. Anbar (with A. Johnson, graduate student)
Project Title: NESSF: How low can we go? Measuring Archean weathering rates in ultra low-O_2 experiments

Award Amount: $120,000
Period of Award: 9/1/17 – 8/31/20

Source of Support: NSF (Frontiers in Earth System Dynamics Program)
Principal Investigator: A. D. Anbar
Project Title: FESD Type I: Dynamics of Earth System Oxygenation
Award Amount: $4,845,000
Period of Award: 9/01/13 – 8/31/20

Source of Support: NASA Astrobiology Program
Principal Investigator: T. W. Lyons (UC Riverside)
Project Title: Alternative Earths: Explaining Persistent Inhabitation on a Dynamic Early Earth
Award Amount: $448,157 to ASU
Period of Award: 4/16/15 – 12/31/20

Source of Support: NASA Astrobiology Program
Principal Investigator: S. Desch (ASU)
Project Title: Exoplanetary Ecosystems: Exploring Life's Detectability on Chemically Diverse Exoplanets
Award Amount: $6,097,436
Period of Award: 12/31/14 – 12/30/20

Source of Support: Alfred P. Sloan Foundation
Principal Investigator: D. Sarewitz (ASU)
Project Title: Exploring Democratic Governance of Geoengineering Research Through Public and Stakeholder Engagement
Award Amount: $299,680
Period of Award: 11/01/17 – 4/30/19

Source of Support: NSF DUE
Principal Investigator: A. D. Anbar (ASU)
Co-Principal Investigators: S. Semken (ASU)
Project Title: Exploration-Driven Online Science Education: Habitable Worlds 2.0
Request Amount: $679,178 (includes original award and $80,100 supplement)
Period of Request: 1/1/13 – 8/30/19

Source of Support: Bill & Melinda Gates Foundation
Principal Investigator: A. D. Anbar (ASU)
Co-Investigators: D. Ben-Naim (ASU and Smart Sparrow, LLC); G. Siemens (UT – Arlington)
Project Title: The Inspark Science Network
Award Amount: $470,000 to ASU (of $4.5 million total award)
Period of Award: 9/1/15 – 8/31/18

Source of Support: NASA (Human Research Program)
Principal Investigator: A. D. Anbar (ASU)
Co-Investigators: G. Gordon, J. Skulan (ASU)
Project Title: Stable calcium isotopes in urine as a biomarker of bone mineral balance in spaceflight

Award Amount: $550,000
Period of Award: 12/01/13 – 11/30/17

Source of Support: NASA (Exobiology Program)
Principal Investigator: A. D. Anbar (ASU)
Co-Investigators: A. Herrmann (LSU); T. Algeo (U. Cincinnati)
Project Title: Uranium Isotope Variations in Carbonates: Validating A New Paleoredox Proxy
Award Amount: $619,292
Period of Award: 9/1/2013 – 8/31/17

Source of Support: Flinn Foundation
Principal Investigator: A. D. Anbar (ASU); K. Cannon (Mayo Clinic)
Project Title: Improving the clinical utility of Ca isotope analysis by assessing population level variation in the Ca isotope composition of blood
Award Amount: $100,000
Period of Award: 9/01/13 – 8/31/16

Source of Support: NSF OCE
Principal Investigator: A. Herrmann (LSU)
Principal Investigator: Lisa Levin (UCSD)
Co-Principal Investigators: A. D. Anbar and G. Gordon (ASU)
Project Title: Ocean Acidification Category 2: Collaborative Research - Development of geochemical proxies to evaluate larval pH-exposure history
Award Amount: $99,633 to ASU
Period of Award: 6/1/11 – 5/31/14

Source of Support: NSF EAR
Principal Investigator: A. Herrmann (ASU)
Co-Principal Investigators: A. Anbar (ASU)
Principal Investigators: T. Algeo (U. Cinn.), J. Barrick (U. Texas), B. Haupt (PSU)
Project Title: COLLABORATIVE RESEARCH: Integrated Paleoceanographic Analysis of the Late Paleozoic Midcontinent Sea
Award Amount: $78,000 to ASU (award to date; not yet fully funded)
Period of Award: 6/1/11 – 5/31/14

Source of Support: NSF OCE
Principal Investigator: A. Herrmann
Co-Principal Investigators: A. D. Anbar, L. E. Wasylenki (now at U. Indiana)
Project Title: Uranium isotopes in carbonate sediments: Assessing a novel paleoredox proxy
Award Amount: $368,544
Period of Award: 6/1/10 – 5/31/14

Source of Support: NSF AGS
Principal Investigator: B. Majestic (NAU; now Denver University) *LEAD INSTITUTION*
Principal Investigator: P. Herckes (ASU)
Co-Principal Investigator: A. D. Anbar (ASU)
Project Title: Collaborative Research: Atmospheric processing of iron - does particle size influence iron solubility?

Award Amount: $220,238 to ASU
Period of Award: 5/1/10 – 4/30/14

Source of Support: NASA
Principal Investigator: S. Semken
Co-Investigators: A. D. Anbar, W. Burelson, K. Hodges, W. Taylor
Project Title: NASA Triad: A Triangulated Program to Promote NASA Stem Education Nationwide
Award Amount: $733,743
Period of Award: 9/1/10 – 8/31/14

Source of Support: NASA Astrobiology Program
Principal Investigator: A. D. Anbar (ASU)
Co-Investigators: S. Desch, J. Elser, J. Farmer, B. Grigsby, K. Hodges, S. Neuer, S. Semken, E. Shock, F. Timmes, M. Wadhwa, M. Zolotov (all at ASU); T. Lyons (UC Riverside); J. Raymond (UC Merced); J. Siefert (Rice)
Project Title: Follow the Elements: A proposal for membership in the NASA Astrobiology Institute
Award Amount: $6,506,153
Period of Award: 1/01/09 – 12/31/14

Source of Support: NSF OCE
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Principal Investigator: B. Majestic (NAU; now Denver University)
Co-Principal Investigator: P. Herckes (ASU)
Project Title: Collaborative Research: Source apportionment of iron in the marine atmosphere - application of stable iron isotopic measurements
Award Amount: $225,202 to ASU
Period of Award: 10/1/10 – 09/30/12

Source of Support: NSF MRI
Principal Investigator: P. Williams
Co-Principal Investigators: A. D. Anbar, J. Anderson, J. Elser, R. Hervig, E. Shock, M. Wadhwa, W. Vermaas
Project Title: Acquisition Of A Nanosims 50L Imaging Secondary Ion Mass Spectrometer
Award Amount: $3,267,586
Period of Award: 2010 – 2012

Source of Support: NSF EAR (Sedimentary Geology and Paleobiology)
Principal Investigator: A. D. Anbar (ASU)
Principal Investigator: G. Jiang (UNLV) *LEAD INSTITUTION*
Principal Investigator: T. Lyons (UC Riverside)
Principal Investigator: S. Xiao (VA Tech)
Project Title: Collaborative Research: Ocean Redox Evolution at the Dawn of Animal Life: An Integrated Geological and Geochemical Study of the Ediacaran Yangtze Platform in South China
Award Amount: $97,209 to ASU
Period of Award: 8/01/08 – 7/31/12

Source of Support: ASU-Mayo Pilot Funding
ASU Investigator #1: A. D. Anbar
ASU Investigator #2: G. W. Gordon
Mayo Investigator #1: R. Fonseca
Project Title: Calcium isotopes: Inorganic Signatures of Multiple Myeloma Progression
Award Amount: $40,000
Period of Award: 7/01/12 – 6/30/13

Source of Support: NSF EAR
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Principal Investigator: T. W. Lyons (UCR)
Co-Principal Investigator: B. Kendall (ASU)
Project Title: Collaborative Research: Examining the evolution of biospheric oxygenation in Late Archean to Middle Proterozoic oceans through high-resolution trace metal chemostratigraphy
Award Amount: $142,143 to ASU
Period of Award: 7/1/10 – 6/30/12

Source of Support: NASA Astrobiology (Exobiology & Evolutionary Biology)
Principal Investigator: A. D. Anbar (ASU)
Collaborator: T. Lyons (UC Riverside)
Project Title: In search of early oxygen: Investigation of redox sensitive metal abundances and isotopes in Neoarchean drill cores
Award Amount: $560,428
Period of Award: 10/01/07 – 9/30/12

Source of Support: NASA Human Research Program
Principal Investigator: A. D. Anbar (ASU)
Collaborators: J. Skulan (U. Wisconsin); S. Smith (JSC); T. D. Bullen (USGS)
Project Title: Rapid measurements of bone loss using tracer-less calcium isotope analysis of blood and urine
Award Amount: $1,096,853
Period of Award: 7/01/08 – 6/30/12

Source of Support: NSF OCE (Chemical Oceanography)
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Co-Principal Investigator: L. E. Wasylenki (ASU)
Principal Investigator: Thomas Spiro (U. Washington)
Project Title: Collaborative Research: Systematics of Zn Isotopes in the Oceans: Assessing the Roles of Surfaces and Speciation
Award Amount: $458,912 to ASU; $112,784 to U. Washington
Period of Award: 9/01/08 – 8/31/11

Source of Support: NSF EAR (Sedimentary Geology and Paleobiology)
Principal Investigator: T. Algeo (U. Cincinnati) *LEAD INSTITUTION*
Co-Principal Investigator: A. D. Anbar (ASU)
Co-Principal Investigator: R. A. Creaser (U. Alberta)
Co-Principal Investigator: L. Schwark (U. Cologne)
Co-Principal Investigator: P. Sauer (U. Indiana)

Project Title: Middle and Upper Devonian Black Shales: Testing the Productivity-Anoxia Feedback and Land Plant-Weathering Rate Hypotheses
Award Amount: ~$20,000 to ASU (subcontract)
Period of Award: 9/01/06 – 8/31/10

Source of Support: Dreyfus Foundation (Environmental Postdoc Program)
Principal Investigator: A. D. Anbar (ASU)
Co-Investigator #1: H. Hartnett (ASU)
Co-Investigator #2: P. Herckes (ASU)
Co-Investigator #3: E. Shock (ASU)
Project Title: Mass Dependent Isotope Fractionation of Bioessential and Toxic Metals: A New Perspective on the Environmental Chemistry of Metals
Award Amount: $120,000
Period of Award: Two+ year fellowship; began 10/2007; no cost extension through 12/10

Source of Support: NSF EAR (Instrumentation & Facilities)
Principal Investigator: A. D. Anbar (ASU)
Co-Principal Investigator: N. Grimm (ASU)
Co- Principal Investigator: L. Leshin (ASU)
Co- Principal Investigator: E. Shock (ASU)
Project Title: Technician Support: ICP-MS Research in the W. M. Keck Foundation Laboratory for Environmental Biogeochemistry
Award Amount: $224,996
Period of Award: 9/01/05 – 9/31/08 (now in second one year no-cost extension)

Source of Support: NSF EAR (Low-Temperature Geochemistry and Geobiology)
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Co-Principal Investigator: L. Wasylenki (ASU)
Co-Principal Investigator: S. L. Brantley (PSU)
Project Title: COLLABORATIVE RESEARCH: Investigation of Fe and Mo Isotope Fractionation During Weathering
Award Amount: $299,621 ($301,690 to PSU)
Period of Award: 9/01/05 – 9/31/09

Source of Support: NSF OCE (Chemical Oceanography)
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Co-Principal Investigator: L. Wasylenki (ASU)
Co-Principal Investigator: T. Spiro (Princeton)
Project Title: COLLABORATIVE RESEARCH: Transition Metal Isotope Fractionation During Adsorption to Authigenic Oxides
Award Amount: $300,074 to ASU ($150,003 to Princeton)
Period of Award: 9/01/05 – 9/31/09

Source of Support: NSF EAR (Biogeosciences)
Principal Investigator: H. Hartnett (ASU)
Co-Principal Investigator: A. D. Anbar (ASU)
Co-Principal Investigator: F. Garcia-Pichel (ASU)

Project Title: Biogeochemistry of Desert Crust Communities: Organic Carbon and Trace Metal Dynamics
Award Amount: $389,331
Period of Award: 7/01/05 – 6/30/09

Source of Support: NSF EAR (Low-Temperature Geochemistry and Geobiology)
Principal Investigator: A. D. Anbar (ASU)
Principal Investigator: T. Lyons (UC Riverside) *LEAD INSTITUTION*
Project Title: Collaborative Research: A Comparative Geochemical Study of the Late Cambrian (SPICE) and Toarcian (Jurassic) Positive Carbon Isotope Excursions as a Window to Paleozoic Oceanic Anoxic Events
Award Amount: $74,517 to ASU
Period of Award: 9/01/07 – 8/31/09

Source of Support: NASA Astrobiology Institute
Principal Investigator: A. D. Anbar (ASU)
Project Title: Proposal for Curation of ADP Drill Cores
Award Amount: $212,954 + $30,000 supplement
Period of Award: 01/05 – 12/31/09

Source of Support: Agouron Foundation
Principal Investigator: A. D. Anbar (ASU)
Project Title: The Rise of Oxygen and the Evolution of the Metallome
Award Amount: $100,000
Period of Award: 3/01/07

Source of Support: NSF OCE (Marine Geology and Geophysics)
Principal Investigator: A. D. Anbar (ASU)
Principal Investigator: S. Severmann (UC Riverside) *LEAD INSTITUTION*
Principal Investigator: J. McManus (Oregon State University)
Project Title: Collaborative Research (UCR, OSU and ASU): Combined Fe-S stable isotopes in modern anoxic environments and the effect of Fe versus S limitation
Award Amount: $38,422 to ASU
Period of Award: 3/01/06 – 2/29/08 (now in one year no-cost extension)

Source of Support: ASU-Mayo Pilot Funding
ASU Investigator #1: A. D. Anbar
ASU Investigator #2: G. Gordon
Mayo Investigator #1: Larry Miller
Mayo Investigator #2: Patricia Carrigan
Project Title: Environmental Factors and Pancreatic Cancer
Award Amount: $40,000
Period of Award: 9/01/05 – 9/31/06

Source of Support: NSF (Geology & Paleontology)
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Project Title: COLLABORATIVE RESEARCH: Presaging Paleoproterozoic Global Change: Geobiology of the Late Archean Eon

Award Amount: $74,624 to ASU ($425,000 to MIT, Harvard, Missouri, Maryland)
Period of Award: 9/15/04 – 9/14/06

Source of Support: NASA (Exobiology)
Principal Investigator: A. D. Anbar (ASU)
Co-Investigator #1: J. Barling (formerly at UR)
Co-Investigator #2: T. W. Lyons (U. Missouri)
Project Title: Mechanisms of Mo Isotope Fractionation: Assessing a New Tool for the Study of Ancient Ocean Redox
Award Amount: $363,617
Period of Award: 5/03 – 4/06

Source of Support: NSF- EAR (Geology & Paleontology)
Principal Investigator: A. D. Anbar (ASU) *LEAD INSTITUTION*
Principal Investigator: T. W. Lyons (U. Missouri)
Co- Principal Investigator: J. Barling (formerly at UR)
Project Title: Collaborative Proposal: Molybdenum Isotopes as Paleoredox Proxies
Award Amount: $224,918 to Rochester ($74,544 to Missouri)
Period of Award: 1/03 – 12/06 (incl. one year no-cost extension)

Source of Support: Astrobiology Science & Technology
Principal Investigator: A. D. Anbar (ASU)
Project Title: Upgrade of MC-ICP-MS Instrumentation
Award Amount: $210,000
Period of Award: 9/04 – 8/06 (incl. one year no-cost extension)

Source of Support: NSF- Academic Research Infrastructure
Principal Investigator: A. Basu (UR)
Co-Principal Investigator(s): A. D. Anbar, R. Poreda (UR)
Project Title: Request for a Technical Associate to Support the Isotope Geochemistry Laboratories at the University of Rochester
Award Amount: $150,000 (orginal grant); ~ $150,000 (renewal)
Period of Award: Original award: 3/98 - 2/02; Renewal + extension: 2/02 – 1/05

Source of Support: NASA Astrobiology Institute
Principal Investigator: Andrew Knoll (Harvard)
Co-Investigator(s): A. D. Anbar (UR) and researchers at Harvard, MIT & Smithsonian
Project Title: The Planetary Context of Biological Evolution
Award Amount: ~$350,000 total to Rochester
Period of Award: 5 years + extension (7/98 – 10/04)

Source of Support: NASA Astrobiology Institute
Principal Investigator: Kenneth Nealson (JPL/Caltech)
Co-Investigator(s): A. D. Anbar (UR) and groups at Caltech/JPL, USGS and U. Wisc.
Project Title: Coevolution of Planets and Biospheres: Lessons from Earth and Mars
Award Amount: ~$250,000 total to Rochester
Award Award: 5 years + extension (7/98 – 10/04)

Source of Support: UR-NIEHS Center for Environmental Health Sciences
Investigators: A. D. Anbar and E. Puzas (UR); J. Skulan (U. Wisconsin)
Project Title: Pilot Project: Ca Isotopes and Osteotoxicology
Award Amount: $23,110
Period of Award: 9/02 – 3/04

Source of Support: Rochester Gas and Electric Co.
Principal Investigator: A. D. Anbar (UR)
Co-Investigator(s): R. J. Poreda (UR)
Project Title: Determination of Tc-99 in Aqueous and Soil Samples by ICP-MS
Award Amount: $71,041
Period of Award: Expired in 2004

Source of Support: NSF- EAR (Geology & Paleontology)
Principal Investigator: A. D. Anbar (UR) *LEAD INSTITUTION*
Principal Investigator: S. L. Brantley (Penn. State)
Project Title: Collaborative Research: Iron & Molybdenum Isotope Fractionation during Mineral Weathering
Award Amount: $100,000 to Rochester
Period of Award: 24 months (5/01 - 4/04; includes one year no-cost extension)

Source of Support: NSF- EAR (Geology & Paleontology)
Principal Investigator: J. Barling (UR)
Co-Principal Investigator: A. D. Anbar
Project Title: Molybdenum Isotopes in the Geologic Record: Paleoredox Proxies?
Award Amount: $100,000
Period of Award: 12 months (8/01 - 7/02; no cost extension to 7/03)

Source of Support: NSF- Life in Extreme Environments (LExEn)
Principal Investigator: A. D. Anbar (UR) *LEAD INSTITUION*
Co- Principal Investigator: Kenneth Nealson (JPL/Caltech)
Project Title: Biogenic Fractionations of Transition Metal Isotopes: Novel Methods for the Examination of Life in Extreme Environments
Award Amount: $270,000
Period of Award: 36 months (10/97 - 9/00)

Source of Support: NSF- Academic Research Infrastructure
Principal Investigator: A. D. Anbar (UR)
Co- Principal Investigator(s): A. Basu, R. Poreda, J. Tarduno, U. Fehn (UR)
Project Title: Acquisition of a High-Resolution Inductively-Coupled Plasma Mass Spectrometer for Research in Trace Element Geochemistry & Biogeochemistry
Award Amount: $294,772 + $50,000 supplement
Period of Award: 24 months (7/96 - 6/98)

Source of Support: Princeton-NSF Center for Environmental Bioinorganic Chemistry
Investigators: A. D. Anbar (UR); T. Spiro and A. Jarzecki (Princeton)
Project Title: Pilot Project: Theoretical Investigations of Transition Metal Isotope Fractionation

Award Amount: $22,000 (internal at Princeton)
Period of Award: 9/02 – 8/03

Source of Support: National Institute of Dental Research
Principal Investigator: T. Clarkson (UR- Med. Center)
Co-Investigator(s): A. D. Anbar, G. Watson (UR- Med. Center)
Project Title: Health Effects of Dental Amalgam in Children
Award Amount: ~$25,000 to Anbar
Period of Award: expired June, 2004

Educational Activities

Research Students Supervised

Graduate Students, as lead or co-mentor (*)

Ph.D. and M.S. Degrees in Progress (at Arizona State University)

Furukawa, Hikaru* (Ph.D. candidate in Geological Sciences, 6th year)
Research Area: Earth energy futures

Edmans, Ethan (Ph.D. candidate in Geological Sciences, 4th year)
Research Area: Metal isotope paleoredox proxies

Tremblay, Catherine* (Ph.D. candidate in Geological Sciences, 4th year)
Research Area: Geochemistry and science education

Lunetto, Sarah (M.S. student in Geological Sciences, 2nd year)
Research Area: Atmospheric implications of mantle redox evolution

Perlman, Eliana (Ph.D. student in Geological Sciences, 2nd year)
Research Area: Metal isotope paleoredox proxies

Nupoor Patil (M.S. student in Biochemistry, 1st year)
Research Area: Arsenic substitution for phosphorus in biomolecules

Completed Degrees, as lead or co-mentor (*)

Vergeli, Pilar* (Ph.D. student in Geological Sciences, 2025)
Research Area: Archean ocean photochemistry
Last Known Position: Postdoctoral Fellow, Carnegie Science

Sarancha, Julianne* (Ph.D. student in Environmental Life Sciences, 2025; defended 2024)
Research Area: Isotope forensics
Last Known Position: Isotope Preparation Scientist, SNA International

Sullivan, Daniel (Ph.D. student in Geological Sciences, 2023)
Research Area: Metal isotope paleoredox proxies
Last Known Position: Postdoc, U.S. Dept. of Energy Pacific Northwest National Lab

Hasty, Brandon (M.S student in Geological Sciences, 2023)
Research Area: Metal isotope paleoredox proxies
Last Known Position: Learning Support Staff, ASU ETX Center

Ren, Yi* (M.S. student in Chemistry, 2023)
Research Area: Biomedical isotopes
Last Known Position: Geosciences Ph.D. student, Temple University

Balanzat, Don* (M.S. student in Geoscience Education, 2022)
Research Area: VR in science education
Last Known Position: Founder, Chaotic Curiosity

Johnson, Aleisha (Ph.D. student in Geological Sciences, ASU, 2020)
Research Area: Mineral weathering
Last Known Position: Postdoctoral Scholar, University of Arizona

Ostrander, Chad (Ph.D. student in Geological Sciences, ASU, 2020)
Research Area: Metal isotope paleoredox proxies
Last Known Position: Assistant Professor, University of Utah

Sherry, Alyssa* (M.S. student in Chemistry, ASU, 2019)
Research Area: Environmental metal isotopes
Last Known Position: Attorney at Fisch Sigler LLP

Chen, Xinming (Ph.D. in Geological Sciences, M.S. in Chemistry, ASU, 2018 and 2015)
Research Area: Uranium Isotope Geochemistry
Last Known Position: Assistant Professor, Shanghai Jiao Tong University

Zhang, Feifei (Ph.D. in Geological Sciences, ASU, 2018)
Research Area: Uranium Isotope Paleoredox Proxy
Last Known Position: Professor, Nanjing University

Castleberry, Parker (M.S. in Chemistry, ASU, 2017)
Research Area: Photogeochemistry
Last Known Position: Unknown

Bradford, Kristi (M.S. in Exploration Systems Design, ASU, 2016)
Research Area: Ca isotopes via laser fluorescence
Last Known Position: Founder and Managing Director, Pragmatic Frontiers

Neveu, Marc* (Ph.D. in Astrophysics, co-advised with Steve Desch, ASU, 2015)
Research Area: Habitability of Extraterrestrial Hydrothermal Systems
Last Known Position: Research Scientist, NASA Goddard Spaceflight Center

Mead, Christopher* (Ph.D. in Geological Sciences, ASU, 2014)
Research Area: Envrionmental Hg and Fe stable isotopes; biogeochemistry concept inventory
Last Known Position: Assistant Research Professor, School of Earth and Space Exploration, ASU

Romaniello, Stephen (Ph.D. in Geological Sciences, ASU, 2012)
Research Area: U isotopes as paleoredox proxies
Last Known Position: Director of Geochemistry, Vesta

Brennecka, Gregory (Ph.D. in Geological Sciences, ASU, 2011)
Research Area: U stable isotopes in geochemistry
Last Known Position: Staff Scientist, Lawrence Livermore National Laboratory

Glass, Jennifer (Ph.D. in Geological Sciences, ASU, 2011)
Research Area: Mo in biology and evolution
Last Known Position: Professor, Georgia Institute of Technology

Morgan, Jennifer (Ph.D. in Chemistry, ASU, 2011)
Research Area: Ca and Fe isotopes in biomedicine
Last Known Position: Senior Scientist, Proctor & Gamble

Duan, Yun (Ph.D. Geological Sciences, ASU, 2010)
Research Area: Fe and Mo isotopes in the geologic record
Last Known Position: Doctor of Physical Therapy, Swedish Medical Center, Seattle, WA

Royer, Nicole (M.S. Natural Sciences, ASU, 2007)
Research Area: Mo isotopes in the environment
Last Known Position: Unknown

Arnold, Gail L. (Ph.D. Geological Sciences, UR, 2004)
Research Area: Trace metals, Mo and Fe isotopes and Precambrian paleoenvironments
Last Known Position: Assistant Dean and Director, University of Texas – El Paso

Domagal-Goldman, Shawn (M.S. Geological Sciences, UR, 2002)
Research Area: Fe isotope fractionation in sediments; atmosphere evolution
Last Known Position: Acting Director, Astrophysics Division, NASA HQ

Jones, Greg (M.S. Geological Sciences, UR, 2003)
Research Area: Distribution of fissionogenic ^{99}Tc in Western New York
Last Known Position: Senior Chemist/Radiochemist, Exelon Generation

Roe, Jo E. (Ph.D. Chemistry, UR, 2003)
Research Area: Development of MC-ICP-MS methods for studying Fe isotope fractionation
Last Known Position: Analyst, Excellus Corp.

Klochko, Katerina (M.S. Geological Sciences, UR, 2003)
Research Area: Mo isotope fractionation in the environment
Last Known Position: Physical Scientist, USGS, Reston VA

Holman, Elizabeth S. (M.S. Geological Sciences, UR, 2001)
Research Area: Theoretical modeling of Fe isotope fractionation
Last Known Position: Assoc. Dir of Assessment & Evaluation, U. Michigan Medical School

Knab, Karen A. (M.S. Chemistry, UR, 1999)
Research Area: Development of MC-ICP-MS methods for measuring Mo isotope fractionations
Last Known Position: Marriage and Family Therapist, Private Practice.

Ramon, Erick (M.S. Geological Sciences, UR, 1999)
Research Area: Redox evolution of the Earth's surface environment

Last Known Position: Staff Scientist, Lawrence Livermore National Laboratory

Undergraduate Students (alphabetical)

Beemiller, Peter (Junior Research, Biology B.S., UR, 2000)
Bercel, Trystyn (Junior Research, Earth & Space Exploration B.S., ASU, 2015)
Carti, Shani (Senior Research, Environmental Studies B.A., UR, 2000)
Diamond, Ashley (Junior Research, Biology B.S., ASU, 2008)
Fancher, Michael (Freshman Research, Chemistry B.S., ASU, 2011)
Fetterhoff, Kristy (Senior Thesis, Chemistry B.S., UR, 1997)
Flores, Aaron (Senior Research, Chemistry B.S., ASU, 2022)
Glukhova, Alisa (Senior Research, Biochemistry B.S., ASU, 2013)
Goldman, Shawn (Senior Research, Physics B.S., UR, 2001)
Gosse, Julie (Summer Research 1998, Chemistry B.S. at U. Mass Amherst, 1999)
Hopson, Emma (Undergraduate Research, Biology B.S., ASU, 2020)
Kaplan, Mark (Senior Thesis, Chemistry B.S., UR, 1997)
Knab, K. A. (Senior Thesis, Environmental Science B.S.; Chemistry B.A., UR, 1998)
LaRossa, Gina (Summer Research 1997; Electrical Engineering B.S. at Yale, 2001)
Manubay, Grace (Senior Research, Environmental Studies B.A., UR, 1999)
Marciano, Santo (Laboratory Asst., Geological Sciences B.S., UR, 2003)
Marshall, Lisa (Senior Thesis, Chemistry B.S., UR, 2001)
Martin, Joe (Senior Research, Environmental Science B.S., UR, 1999)
Martinez, Zuriyema (Senior Research, Biochemistry B.S, ASU, 2012)
Missell, Christine (Summer Research 1999, Geology B.S. at U. Maryland, 2001)
Montanez, Gabriela (Senior Research, Chemical Engineering B.S., ASU, 2010)
Murray, Joseph (Undergraduate Research, Chemistry B.S., ASU, 2011)
Ostrander, Chad (Undergraduate Research, Geological Sciences B.S., ASU, 2016)
Peters, K. (Senior Research, Environmental Science B.S., UR, 1997)
Polizzotto, Matt (Senior Research, Environmental Science B.S., UR, 2001)
Rajopadhye, Aseem (Junior Research, Astrobiology and Biogeosciences B.S., ASU, 2026)
Ramon, E. (Senior Research, Biology-Geology B.S., UR, 1997)
Roche, Erik (Senior Research, Chemistry B.A., UR, 1999)
Rolfe, Bryan (Freshman – Junior Research, Chemical Engineering B.S., ASU, 2009)
Sabin, Christie (Senior Research, Biochemistry B.S., ASU, 2013)
Schultz, Laura (Senior Research, Chemistry B.S., ASU, 2008)
Shollenberger, Quinn (Undergraduate Research, Chemistry B.S., ASU, 2014)
Tegler, Logan (Undergraduate Research, Chemistry B.S., ASU, 2018)
Spaul, Hannah (Senior Research, Environmental Studies B.A., UR, 1998)
Stewart, Audrey (Laboratory Asst., Environmental Sciences B.S., UR, 2004)

Valdez, Emma (Undergraduate Research, Astrobiology B.S., ASU, 2021)
Wayne, Lily (Undergraduate Research, Biochemistry B.S., ASU, 2019)
Webber, Ben (Senior Research, Chemistry B.S., UR, 2004)
Williams, Teidra (Junior Research, Life Sciences, B.S., ASU, 2008)

Courses Taught
(most recent listed first)

Arizona State University

GLG/BIO/SEA 325/SMS 385- Oceanography
Semesters Taught: Fall '25 (3 credits)
Introduces marine geology, chemistry, and physical and biological oceanography. Methods of oceanic exploration, environmental and social aspects of oceans.

SES/CHM 598- Mysteries of Metallome Evolution
Semesters Taught: Spring '25 (3 credits)
Course explores the evolution of the metallome, examining the geochemical and biomolecular histories of key metals and their role in life's major transitions.

SES 106 (originally GLG 106)- Habitable Worlds
Semesters Taught: Fall '10-'12, '14, '15, '19, '20, '23, '24; Spring '17, '18, '23 (4 credits; carries ASU SQ credit)
Using the search for life on other worlds as motivation, introduces students to basic concepts in astronomy, geosciences, chemistry, and biology needed to understand what makes the Earth a planet conducive to supporting life. Equips students to understand the future of our inhabited world and the search for life beyond our own. Class size: Offered as a pilot hybrid course to ~ 30 students in 2010, fully online to ~ 150 students in 2011, and to ~ 400 students/offering since 2012. Also offered as an ASU ULC course.

GLG/CHM 598/494- Biogeochemical Evolution of Earth
Semesters Taught: Spring '14, '21, 24; Fall '15 (3 credits)
A graduate seminar covering basic concepts and key topics pertaining to Earth's habitability, its evolution over time, and co-evolution with life.

CHM 302- Environmental Chemistry
Semesters Taught: Fall '08, '09, '11, '17, 22 (3 credits)
An introduction to chemistry in the environment. Explores major environmental issues, problems, and solutions from analytical and chemical perspectives. Class size: ~ 100

SES 311- Essentials of Astrobiology
Semesters Taught: Spring '22 (3 credits)
An introduction to astrobiology concept and principles. Class size: ~ 50

GLG 581/CHM 598- Isotope Geochemistry
Semesters Taught: Spring '05, '07, '09, '11, '13, 15, '20; Fall '16 (3 credits)
An introduction to the basic concepts of stable and radiogenic isotope geochemistry. The course includes lectures, reading-and-discussion sessions and laboratory tutorials/demonstrations. Class size: ~ 10.

GLG 591- Archean Geophysics
Semesters Taught: Fall '14 (1 credit)

An overview of Archean geophysical processes and their environmental consequences.

CHM 501- Current Topics in Geochemistry and Environmental Chemistry
Semesters Taught: Fall '07, '08, '09, '13, Spring '11, '16, '18 (1 credit)
Topical reading and research seminar/practicum in geochemistry an environmental chemistry.

SOS 513/GLG 490- Science for Sustainability (cross-listed as CHM 598/494, Chemistry for Sustainability)
Semesters Taught: Spring '08 (3 credits)
An orientation to natural science concepts and paradigms necessary to understand critical topics in sustainability, particularly related to global climate change. Subjects covered include the carbon cycle, nutrient cycles, carbon and nutrients in the oceans, climate change, oxygen and ozone, solid waste pollution, urban air pollution. Class size: 24.

GLG 191- Alternative Earths: Past, Future and Beyond (1st Year Seminar)
Semesters Taught: Fall '07 (1 credit)
It is only a matter of time before Earth-like planets are discovered orbiting stars other than the Sun. Will we find that environments like ours hospitable to life are common? Through examination of the four billion years of "coevolution" of life and the environment on this planet, students will gain perspective on how our civilization is shaping the Earth's future and on the prospects for life on the alternative Earths that lie beyond. Class size: ~ 10.

ASU 101- The ASU Experience
Semesters Taught: Fall '07 (1 credit)
A required class for all ASU students to teach skills needed for success in college. Class size: ~ 10.

CHM 113- General Chemistry
Semesters Taught: Fall '05, '06 (3 credits + lab)
A college-level introduction to the basic concepts of chemistry. First course in a two-semester sequence. The course includes lectures, discussion sessions and a laboratory. Class size: ~ 200.

GLG 598/490- Habitable World (cross-listed as CHM 582)
Semesters Taught: Spring '06 (3 credits)
A first course in Earth System Science for graduates and advanced undergraduates. Topics covered include planetary climate, Earth history, biogeochemical cycles; atmosphere and ocean chemistry. Class size: ~ 10.

University of Rochester

EES 103- Habitable World: An Introduction to Environmental Science
Semesters Taught: Spring '02, '03, '04 (4 credits)
An introduction to the natural physical, chemical, biological and geological processes that shape conditions at the Earth's surface, their interrelationships, and the modification of these processes by human activity. Students will learn to critically analyze scientific hypotheses and the data on which they are founded. The content of this course is similar to that of the AP Environmental Science curriculum. Class size: 25 – 40.

EES 218- The Chemistry of Global Change
Semesters Taught: Fall '01, '02, '03 (4 credits)
Quantitative survey of the processes controlling environmental conditions at the Earth's surface today, how they have changed with time, and how they are expected to change in the future. The course emphasizes the chemical composition of the atmosphere and oceans, and the chemical, biological and geological processes which affect this composition. Specific topics include: greenhouse gases and global warming; photochemistry and stratospheric ozone; geochemical cycles and feedbacks; the effects of human activities; and the methods used to study the chemical evolution of the atmosphere and oceans. Class size: 15 – 25.

EES 261/461- Aqueous Geochemistry
Semesters Taught: Fall '98, Fall '00 (4 credits)
An introduction to the chemistry of water in the environment, including both pristine and polluted systems. The composition and behavior of atmospheric waters, groundwaters and seawater will be studied through the application of principles of inorganic chemistry and geology. Offered alternate fall semesters. Class size: ~ 15

EES 216- Environmental Geochemistry
Semesters Taught: Spring '97, '98, '99, '00 (4 credits)
A course in the chemical and physical processes that shape our environment. These include groundwater flow and contaminant migration, chemistry of lakes, streams and the ocean, ocean-atmosphere interactions, (ozone depletion) global warming and the greenhouse effect. Class size: 30 - 50

EES 466- Stable Isotope Geochemistry: Beyond the Light Elements
Semesters Taught: Spring '00 (4 credits)
Historically, research in stable isotope geochemistry has focused on isotope fractionation of H, B, O, C, N and S. However, recent work at Rochester and elsewhere has shown that the isotopes of many heavier elements also undergo measurable fractionation in nature. This research seminar will focus on these emerging stable isotope systems, with a focus on analytical methods and potential applications. Specific isotope systems to be covered include (at least): Ca, Se, Fe, Cu, Zn and Mo. Students will be expected to keep up with reading assignments, prepare informal presentations, and participate in discussions. A term project or paper is also required. Class size: ~ 5

EES 263/463- Seminar in Biogeochemistry (Astrobiology)
Semesters Taught: Spring '96, '99, '02 '03 (4 credits)
Current topics in biogeochemistry, focusing on the interface between biological and geological processes in ancient and modern environments. Coursework includes readings from the primary research literature, presentations, student-led discussions and a term paper or project. Class size: 5 - 10

EES 265/465- Chemistry of Atmospheres
Semesters Taught: Fall '97, Fall '99 (4 credits)
An introduction to the chemistry of the Earth's atmosphere, and the atmospheres of the other planets and their satellites. Special emphasis on photochemistry and chemical kinetics, and modeling of these processes in atmospheres. Effects of life and of human activities on the atmosphere will be examined,

as well as the chemical evolution of the atmosphere through Earth history. Offered alternate fall semesters (odd years). Class size: ~ 15.

EES 100Q- The Early Earth and the Origin of Life (1st Year "Quest" Course)
Semesters Taught: Fall '96 (4 credits), Spring '97 (EES 200), Spring '98 (2 credits)
Students will focus on conditions of the early Earth and theories of the origin of life through presentations, discussions and debates, guided by their readings of primary research articles. This course is designed to reinforce basic concepts in chemistry, biology and earth science in a problem-oriented manner, and to demonstrate the interrelationships between specific disciplines. Students will learn to critically and quantitatively analyze scientific hypotheses, and the data on which they are founded. Class size: ~ 15.

CAS 160- Public Speaking
Semesters Taught: Fall '97 (2 credits)
The intent of this course is to provide students the opportunity to improve their oral presentation and interview skills. Various presentation types will be covered, including scientific, business and instructional presentations, speeches, and extemporaneous speaking. Students will develop skills as both interviewers and interviewees. Class size: ~ 10.

Other Significant Educational Activities

Arizona State University

Director, Center for Education Through Exploration
School of Earth & Space Exploration, 2015 – present
Direct a team of ~ 15 staff developing digital learning experiences that feature guided active learning for ASU and non-ASU use. Flagship projects include the $10 million NASA Infiniscope project (http://infiniscope.org), contributions to the new SESE Astronomy online program, as well as several projects with the School of Sustainability, and two funded projects with the Howard Hughes Medical Institute.

Online Course Development
School of Earth & Space Exploration and ASU Online, 2009 – present
Articulated curricular and pedagogical goals for an interactive online quantitative science course that would be part of the BA curriculum in Earth and Environmental Studies, leading to the development and offering of Habitable Worlds (GLG 106). Effort dovetailed with development of the Arizona Science Education Collaborative (ASEC) between CLAS and the Mary Lou Fulton Teacher's College. Software development was supported by funds from ASU Online, CLAS, and the NASA Astrobiology Program. This course was offered by Anbar as a hybrid course in Fall '10, then fully online in Fall '11 and Fall '12. It was offered by development partner Dr. Lev Horodyskyj in Spring '12. See: http://habworlds.org.

Academic Program Reform
Arizona State University, 2013 – 2014
In Fall Semester, 2013, chaired a Working Group charged by Provost Elizabeth Phillips to reconceptualize the ASU general education curriculum required of all ASU students. The group

included 6 faculty from across the university's knowledge domains. Our recommendations, explained in a draft report submitted to the Provost's Office in December, 2012, called for a general studies curriculum in which courses across knowledge domains would be organized around, and motivated by, thematic, transdisciplinary, multi-year projects.

TED-Ed Video – Finding Habitable Worlds
School of Earth & Space Exploration, Spring-Summer-Fall 2012
Devised concept and script for a TED-Ed video, and associated "flipped" lesson, about the search for habitable worlds beyond the Earth. See: http://ed.ted.com/lessons/a-needle-in-countless-haystacks-finding-habitable-planets-ariel-anbar.

Education Research
School of Earth & Space Exploration, 2010 – 2015
Developed a funded research plan for the NSF program *Transforming Undergraduate Education in STEM*, centered on modification and assessment of effectiveness of Habitable Worlds (GLG 106) as a platform to teach scientific reasoning. Awarded $600,000 (Co-PI: Prof. Steven Semken). Project begins in January, 2013. Also served as Co-I with PI Steven Semken on a NASA project to infuse NASA science content into the national K-12 geoscience curricula.

Virtual Field Trip Development
School of Earth & Space Exploration and AZ Sci. Ed. Collaborative (ASEC), 2010 – present
With financial support from NASA, ASU Online, and the Mary Lou Fulton Teachers College, oversaw effort by the ASU Astrobiology Program to develop a suite of scientific "virtual field trips". These products, developed by technologist Mr. Geoffrey Bruce, are being used in Habitable Worlds, by ASEC, and by faculty in the School of Human Evolution and Social Change (SHESC). See: http://vft.asu.edu.

Curriculum Development
School of Sustainability (SOS), 2006 – 2008
Helped Profs. Charles Redman and Charles Perrings devise curricula for ABOR approval of SOS curriculum, based on the syllabi for EES 103 ("Habitable World") and EES 218 ("Chemistry of Global Change"). These provided models for SOS 513 ("Science for Sustainability") and SOS 110 ("Sustainable World"). Also served as the first instructor for SOS 513 in Spring, 2008.

Curriculum Development
Dept. of Chemistry & Biochemistry, 2008 – 2009
Worked with faculty in the environmental/geochemistry division of the Department as well as faculty on the department's Committee on Sustainability to explore reinventing the Environmental Chemistry undergraduate degree program as a Sustainable Chemistry program.

Honors Disciplinary Advisor
Dept. of Geological Sciences and School of Earth & Space Exploration, 2005 – 2009
Worked with faculty in the Dept. of Geological Sciences (later the School of Earth & Space Exploration) and staff at the Barrett Honors College to facilitate connections between Barrett students and the Dept. Includes connecting Honors majors with potential thesis advisors and raising awareness of geosciences among Honors students.

University of Rochester

Faculty-in-Residence
Crosby Hall: '96 – '97; Hoeing Hall: '97 – '98; '98 – '99
Lived in undergraduate residence hall. Planned and executed programming designed to stimulate student/faculty interactions outside the classroom.

Residential College Commission
Residential Life Subcommittee, Fall '97 – '99
Participated as one of two faculty representatives, and co-author of final report. The subcommittee was charged with developing recommendations to improve the collegiate experience for students in residence at UR. The major recommendation of the report was to call for unified freshman housing.

Freshman Housing Implementation Committee/Freshman Advisory Committee
Spring '00 – Spring '02
Participated in planning for freshman housing implementation. Chaired subcommittee dealing with impact on fraternities and special interest housing, subcommittee elucidating mechanisms to link the freshman class and the College, and subcommittee on modifying freshman orientation experience.

Faculty Advisor, Sigma Epsilon Fraternity
Spring '01 – present
Worked with students to develop academically-oriented programs.

Hillel of Rochester Area Colleges, V.P.- Campus Affairs
Fall '01 – Fall '02
Oversaw review of Hillel-supported campus programming for undergraduate Jewish students.

National

Inspark Science Network
Academic Lead, 2015 – present
Inspark (http://inspark.education) is a digital teaching network created as part of a $4.5 million award from the Bill and Melinda Gates Foundation to a partnership led by edtech pioneer Smart Sparrow and ASU. It brings together > 100 instructors at > 50 community colleges and other institutions around the country to advance the art of digital teaching and learning, focused in particular on low-income and disadvantaged learners, following a model of learning design developed in ASU Center for Education Through eXploration.

Online Course Development
Center for Education Through Exploration and the Open Learning Initiative at Carnegie Mellon University 2021 – present
Served as ASU PI for a collaborative project with Carnegie Mellon University to develop and distribute REAL CHEM, general studies chemistry courseware, supported by the Gates Foundation. REAL CHEM used a variety of evidence-based best practices to enhance the success of all students, with a particular focus on students from minoritized communities.