GAIL LEE ARNOLD
email: gail.l.arnold@gmail.com

EXPERTISE
Low temperature geochemistry; Molybdenum and iron isotopes to elucidate low and high temperature processes; Development of novel isotope systems as proxies for environmental conditions; Effect of trace metal availability/limitation on biogeochemical processes.

PROFESSIONAL STATISTICS
Researcher ID A-5572-2010; h-index = 12; Total Times Cited 1,374 (as of 12/14/2016)
GOOGLE SCHOLAR PROFILE: https://scholar.google.com/citations?user=jdcAI3kAAAAJ

EDUCATION
UNIVERSITY OF ROCHESTER — Geological Sciences — Ph.D. - May 2004
Title: I. Molybdenum Isotopes: Potential Paleoredox Probes; II. Fe Isotope Variations in Natural Materials Measured Using High Mass Resolution Multiple Collector ICPMS; III. Extraterrestrial Iridium, Sediment Accumulation and the Habitability of the Early Earth's Surface

UNIVERSITY OF ROCHESTER — Geological Sciences — M.S. – January 2001

UNIVERSITY OF THE SOUTH PACIFIC SCHOOL OF AGRICULTURE — Agriculture — M.S. – November 1996

STATE UNIVERSITY OF NEW YORK COLLEGE AT OSWEGO — Geology, Minor: Forensic Science — B.S. – August 1995

APPOINTMENTS
RESEARCH ASSISTANT PROFESSOR — Jan. 2014 – present
Department of Geological Sciences, University of Texas at El Paso

SCIENTIST — Feb. 2013 – Dec. 2013
Center for Geomicrobiology, Aarhus University

SCIENTIST — Jan. 2008 – Aug. 2012
Department of Biogeochemistry, Max Planck Institute for Marine Microbiology

ASSISTANT RESEARCH SCIENTIST — Oct. 2005 – Sept. 2007
School of Earth and Space Exploration, Arizona State University

POSTDOCTORAL SCHOLAR IN GEOBIOLOGY — July 2004 – Oct. 2005
Jet Propulsion Laboratory, California Institute of Technology

GRADUATE RESEARCH & TEACHING ASSISTANT — Aug. 1997 – May 2004
Department of Earth and Environmental Sciences, University of Rochester

GRADUATE RESEARCH ASSISTANT — Feb. 1996 – Dec. 1996
University of the South Pacific School of Agriculture, Alafua, Samoa

FULBRIGHT SCHOLAR, WESTERN SAMOA — Feb. 1996 – Dec. 1996
University of the South Pacific School of Agriculture, Alafua, Samoa

RESEARCH AIDE (Undergraduate Fellowship) — June 1994 – May 1995
Environmental Research Center at Oswego, SUNY Oswego

FIELD & RESEARCH CRUISE EXPERIENCE

Geomicrobiology of the Skagerrak-Kattegat	R/V Aurora	26 Aug. 2014 – 2 Sept. 2014
Kumano Mud Volcano (Jamstec EXP906)	D/S Chikyu	21 June 2012 – 30 June 2012
Argentine Basin (M78/3)	R/V Meteor	17 June 2009 – 10 July 2012
Benguela upwelling region (M76/1)	R/V Meteor	11 April 2008 – 15 May 2008
Mauritania (Mesozoic volcanics sampling)	Fieldwork	25 Feb. 2007 – 18 March 2007

HONORS & AWARDS

Fulbright Scholarship to Western Samoa, 1996; NAGT summer field course scholarship, 1995; Outstanding Geology Graduate, SUNY Oswego, 1995; Phi Kappa Phi, member since 1995; Sigma Xi, Oswego Chapter, member since 1995; Undergraduate Student Fellowship, Environmental Research Center at Oswego, 1994-1995; Vega, Junior/Senior Women's Honor Society at SUNY Oswego, 1993

TEACHING & MENTORING

- Scientific Writing – graduate level (Master's and Doctoral) course for **Department of Geological Sciences at UTEP**, first taught in Spring 2014 (21 students Spring 2014, 25 students Spring 2015, 13 students Spring 2016), will be offered every Spring Semester. Current course encompasses both proposal preparation as well as thesis, dissertation, and manuscript preparation. Future course development will separate proposal preparation from preparation of thesis, dissertation, and manuscripts.
- Scientific Presentations/Communication – graduate level (Master's and Doctoral) course for **Department of Geological Sciences at UTEP**, first taught Fall 2014 (17 students Fall 2014, 17 students Fall 2015), will be offered every Fall Semester. Course topics and workshops span the full range from a student's first CV/resume and introduction, over interviews, elevator talks, chalk talks, conference posters, to conference and defense presentations.
- Co-taught Geomicrobiology at Aarhus University. Responsible for section on introduction to isotopes and isotope nomenclature, principles of isotope fractionation, analysis of mass balances and fluxes: box models and the concept of steady state, closed systems: isotope equilibrium and Rayleigh distillation, isotope fractionation by biogeochemical processes.
- Introduction to laboratory techniques and good laboratory practice – course for graduate students, independently developed yearly section for Max Planck Institute Ph.D. program.
- Mentor for Master and Ph.D. students in scientific communication through presentation and manuscript preparation at the Max Planck Institute for Marine Microbiology.
- Co-mentor of Ph.D. student Yun Duan at Arizona State University.
- Mentor of summer research student (Shannon Greene, Caltech) project and co-mentor of two other summer research student projects at the NASA Jet Propulsion Laboratory.
- Organization and coordination of yearly field trips (10 day) to California for an introductory geology course for the University of Rochester.
- Organization and coordination of yearly field trips (2 day) to Adirondack Mountains for an introductory geology course for the University of Rochester.

- Teaching of introductory geology laboratory course, 4 years' experience (independently developed curricula coordinated to match with lecture course, supervising 3 to 4 other lab lecturers), designed/wrote and graded exams for lecture course.
- Teaching of soil chemistry lecture and laboratory course, responsible for development and presentation of lectures and preparation, instruction and evaluation of student laboratories at the University of the South Pacific School of Agriculture.

PUBLICATIONS

Brunner, B., **G.L. Arnold**, H. Røy, Müller, I.A., and B.B. Jørgensen (2016), Off Limits: Sulfate below the Sulfate-Methane Transition: Frontiers in Earth Science, p. 75, doi: 10.3389/feart.2016.00075.

Deusner, C., T. Holler, **G.L. Arnold**, S.M. Bernasconi, M.J. Formolo, B. Brunner (2014), Sulfur and oxygen isotope fractionation during sulfate reduction coupled to anaerobic oxidation of methane is dependent on methane concentration, *Earth and Planetary Science Letters*, 399, 61-73, doi: 10.1016/j.epsl.2014.04.047.

Arnold, G.L., B. Brunner, I.A. Müller, H. Røy (2014), Modern applications for a total sulfur reduction distillation method - what's old is new again, *Geochemical Transactions*, 15, 4, doi: 10.1186/1467-4866-15-4.

Scott, C, 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, T.W. Lyons (2013), Bioavailability of zinc in marine systems through time, *Nature Geoscience*, 6, 125-128, doi: 10.1038/ngeo1679.

Arnold, G.L., T.W. Lyons, G.W. Gordon, 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, doi:10.1130/G32932.1

Brunner, B., F. Einsiedl, **G.L. Arnold**, I. Müller, S. Templer, and S.M. Bernasconi (2012), The reversibility of dissimilatory sulphate reduction and the cell-internal multi-step reduction of sulphite to sulphide: insights from the oxygen isotope composition of sulphate, *Isotopes in Environmental and Health Studies*, 48, 33–54, doi:10.1080/10256016.2011.608128.

Henkel, S., M. Strasser, T. Schwenk, T. Hanebuth, J. Hüsener, **G.L. Arnold**, D. Winkelmann, M. Formolo, J. Tomasini, S. Krastel, and S. Kasten (2011), An interdisciplinary investigation of a recent submarine mass transport deposit at the continental margin off Uruguay, *Geochemistry Geophysics Geosystems*, 12, Q08009, doi:0.1029/2011GC003669.

Duan, Y., 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.

Garvin, J., 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.

Gordon, G.W., T.W. Lyons, **G.L. Arnold**, J. Roe, B.B. Sageman, and A.D. Anbar (2009), When do black shales tell molybdenum isotope tales?, *Geology*, 37, 535–538, doi:10.1130/G25186A.1.

Anbar, A.D., Y. Duan, T.W. Lyons, **G.L. Arnold**, B. Kendall, R.A. Creaser, A.J. Kaufman, G.W. Gordon, C. Scott, J. Garvin, and R. Buick (2007), A whiff of oxygen before the great oxidation event?, *Science*, 317, 1903–1906.

Kaufman, A.J., 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.

Arnold, G.L., A.D. Anbar, J. Barling, and T.W. Lyons (2004a), Molybdenum isotope evidence for widespread anoxia in mid-proterozoic oceans, *Science*, 304, 87–90, doi:10.1126/science.1091785.

Arnold, G.L., S. Weyer, and A.D. Anbar (2004b), Fe isotope variations in natural materials measured using high mass resolution multiple collector ICPMS, *Analytical chemistry*, 76, 322–327.

Anbar, A.D., 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.

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

Chiarenzelli, J., R. Scrudato, **G. Arnold**, M. Wunderlich, and D. Rafferty (1996), Volatilization of polychlorinated biphenyls from sediment during drying at ambient conditions, *Chemosphere*, 33, 899–911.

GRANTS SUBMITTED & PENDING

Velasco, Aaron A (Principal), Lougheed, Vanessa L (Co-Principal), Villanueva-Rosales, Natalia (Co-Principal), Chakraborty, Jayajit (Co-Principal), Kumar, Vinod (Co-Principal), Jin, Lixin (Co-Principal), **Arnold, Gail** (Co-Principal), "NRT: VIGILANT: Volcanic Impacts on the Geo-social system – Interdisciplinary Learning And Network Training.," Sponsored by NSF, Federal. Not Funded. Preparing for resubmission in January 2017.

Arnold, Gail (PI), "Characterization of the molybdenum isotope composition of molybdenites within Climax-type deposits – Testing the enriched cratonic block hypothesis", UTEP-URI program, $5,000 (September 1, 2014 - August 31, 2015). Preparing for submission to NSF Petrology and Geochemistry Program, target deadline January 2017.

Arnold, Gail (PI), "Characterization of the molybdenum isotope composition of molybdenites within the Sierrita Mine, AZ", UTEP-URI program, $5,000 (September 1, 2015 - August 31, 2016). **Funded**.

Brunner, Benjamin and Arnold, Gail L. (PIs), "Assessment of Cryptic Sulfur Cycling in Marine Sediments", NSF, $347,201 (September 1, 2015 - August 31, 2018). Submitted February 2015. Not funded.

Ma, Lin, Arnold, Gail L., Brunner, Benjamin, and Jin, Lixin (PIs), "Acquisition of a Quadrupole Inductively Coupled Plasma Mass Spectrometer with Hydride Generator to Expand Research and Teaching in the Environmental Sciences", submitted to the Department of Defense, $230,408. Not funded.

Arnold, Gail L. and Brunner, Benjamin (PIs), "The biogeochemistry of iron, manganese and sulfur cycling across the Kattegat – Skagerrak (Baltic) Seabed", NSF, $185,248 (September 1, 2014 - August 31, 2016). Submitted February 2014. Not funded.

Ma, Lin, Arnold, Gail L., Brunner, Benjamin, and Jin, Lixin (PIs), "Early Career: Acquisition of a Quadrupole Inductively Coupled Plasma Mass Spectrometer and a Hydride Generator for trace elemental analysis to enhance geochemical and environmental research", submitted to the NSF Instrument Fund, $322,274. Not funded.

Arnold, Gail (PI), "Characterization of the molybdenum isotope composition of molybdenites within the Sierrita Mine, AZ", UTEP-URI program, $5,000 (September 1, 2014 - August 31, 2015). Not funded.

RESEARCH INTERESTS

I am a geochemist who specializes in trace-metal, heavy stable isotope geochemistry and its application to modern and historical environmental change. My developmental work on iron and molybdenum isotope analysis by multiple collector-inductively coupled plasma source mass spectrometry (MC-ICPMS) is a cornerstone for research on non-traditional stable isotopes. This skill-set, together with my expertise in paleo-proxy research and geomicrobiology allow me to address a broad range of research themes where metals play a key role. At the University of Texas at El Paso (UTEP), I would like to develop a research program that is based on the following three pillars,

Metals as essential constituents for life

Metals are essential for all organisms. For example, molybdenum is an important co-factor in enzymatic processes, playing a key role in the biogeochemical cycles of nitrogen and sulfur. While molybdenum is the only 2nd-row transition metal to be found in biomolecules, it is found in nearly all organisms in all kingdoms of life. Limitations in the supply of bio-available molybdenum or restriction in molybdenum uptake capability can severely affect the mode of function of an ecosystem, from local agricultural applications to global ocean change. So far, studies addressing the effects of metal limitation on ecosystems often ignored key geochemical parameters, especially the existence of other compounds that negatively or positively impact the uptake of bio-limiting metals. My research on bio-limiting metals will target this interplay, filling a fundamental gap in knowledge.

Metals as paleo-proxies in the sedimentary records

Magnesium and strontium isotope compositions in carbonate rocks are currently being used as paleo-proxies to assess the timing and mechanism of the deposition of carbonate sedimentary sequences. I intend to expand the use of this combined isotope system to constrain the genesis and timing of emplacement of diagenetic carbonate sequences (so-called cap-rocks) found in salt-diapir settings. Cap-rocks are integral parts of oil-reservoir systems, serving as means of hydrocarbon retention or loss, depending on the mechanism of cap-rock formation. The precipitation of carbonate minerals such as calcite or dolomite and the transformation of calcite into dolomite and vice-versa, exert a major control on the porosity and permeability of cap-rocks. It is unclear if the mineral transformation are mediated by microbes and, if so, what mineralization coincides with a specific microbial process. A better understanding of cap-rock formation will provide criteria that allow for the assessment of specific cap-rock settings regarding the potential hydrocarbon reservoirs and boost future hydrocarbon development.

Metal isotope compositions as indicators of ore-forming processes

In the last 13 years, the molybdenum isotope system has gained much attention due to its application as an indicator for the presence of sulfide, and hence absence of oxygen, in the world's oceans. Although many researchers have measured the molybdenum isotope composition of molybdenum-sulfide ore minerals – molybdenites, these measurements were done to establish the representative end member composition of the global molybdenum isotope mass balance. Despite the abundance of molybdenum isotope composition measurements that have been made on molybdenite samples, little is known about what controls the molybdenum isotope composition in an ore deposit and what a shift in the molybdenite-molybdenum isotope composition might indicate about the source of the metal, the grade and timing of the emplacement, or thermometry of a deposit.

The University of Texas at El Paso provides an excellent setting in which I can pursue all avenues of metal and metal isotope research. As a member of the Center for Earth and Environmental Isotope Research (CEEIR), I have access to the clean lab and analytical infrastructure necessary for my research plans. The geographical proximity to research locations, be it research on soils, ores or oil reservoirs make El Paso an ideal place for my scientific interests. While my research integrates into existing facilities, it does not create overlap with other investigators from UTEP, instead opening up new avenues and synergies. For example, the research pillar *Metals as essential constituents for life* has a high potential to amplify research on soils (Dr. Jin) and on sulfur metabolism (Dr. Brunner, CEEIR), the research pillar *Metals as paleo-proxies in the sedimentary records* will provide new avenues for understanding halokinetic sequences and fluid migration in oil reservoirs (Drs. Brunner, Giles, Langford; Institute for Tectonic Studies ITS), and the pillar *Metals as indicators of ore-forming processes* (Drs. Goodell, Pingitore; Center for Entrepreneurial Geosciences) will create new options for ore exploration. I am eager to collaborate with scientists with background in all disciplines and I'm convinced that such work will result in new and very exciting insights across many disciplines from geochemistry to oceanography to the geochemical evolution of our planet.

TEACHING PHILOSOPHY

I summarize my teaching philosophy into two words: *Interaction and Integration*. Interaction and integration emphasizes the fact that students achieve high learning performance and retention of the acquired knowledge when they are personally and strongly engaged in the studied topic. I create student engagement by fostering the interactions between students (and teacher) by encouraging students to integrate themselves with each other in teams. This philosophy spans the range from specialty graduate classes down to large-scale introductory undergraduate classes.

Course series that I currently teach at UTEP

At the graduate level, I have *implemented the interact-integrate philosophy* into a course series I am developing under the umbrella of 'scientific communication'. The first course in this series (currently being taught in Fall semesters, present course title, 'Scientific Communication') is designed for first semester Master's and Ph.D. students. The course spans the full range from a student's first CV/resume and introduction, over interviews, elevator talks, chalk talks, conference posters, to conference and defense presentations. On a weekly basis, each student must stand-up in front of the class and speak about their research project and goals in the framework of that week's theme. Additionally, the students are sub-divided into mixed-discipline cohorts (e.g. one student from geophysics, geochemistry, tectonics and geo-informatics per cohort). The students learn that not only must they be able to communicate geophysicist to geophysicist, but also geophysicist to geochemist. Because the students must integrate their own research into each discussion, I observe a rapid progression and evolution of the students' thesis/dissertation conceptualization. The second course in this series (taught in Spring as 'Scientific Writing', with separated sections for proposal vs. thesis writing) is the natural next step in the communication series. Following their degree program, a graduate student must submit their thesis/dissertation proposals prior to the beginning of their 3rd semester. The first portion of the semester focuses on the technical aspects of scientific writing while the second half of the semester takes the form of a writing workshop where the students must write, edit, and re-draft the sections of their proposals. Following this methodology, a student will have, at the least, a working draft of their proposal to finalize with the guidance of their supervisor, and at best, a completed, to be submitted proposal. In addition, the students have received the initial training needed to prepare their own NSF-type proposals, a skill-set that most graduate students have never had the opportunity to acquire at such as early stage. The last course in this series, to yet be developed, will focus on taking the completed body of scientific work to the publication stage, either as a thesis/dissertation or as a manuscript to be submitted to a scientific journal. The first two courses in this series serve as a fantastic foundation for our students at UTEP, providing them with a 'jump-start' in their scientific development and fast-tracking them to the successful and timely completion of their graduate degree.

Other classes I would like to develop;

- Analytical techniques in Geochemistry (hands-on training on in-house instrumentation)
- Non-traditional stable isotopes (with a focus on quality control and data analysis)
- Environmental geochemistry in the lab and field (undergraduate senior-level course)

Hands-on training of students in cutting-edge technologies

I bring substantial body of knowledge to contribute to the training of students, both undergraduate and graduate at UTEP. I have been in the forefront of the developing metal isotope field and am intimately familiar with complexities of producing high quality metal isotope data. My extensive experience working in metal-free clean laboratories combined with my expertise in metal concentrations analysis, stable metal isotope and light stable isotope geochemistry is essential for the design of meaningful experiments. The standards and protocols that I utilize on a daily basis are applicable to low-temperature and high-temperature geochemistry as well as to geomicrobiological and biological studies. In support of the continued growth of CEEIR, I am a Co-PI on a grants for the acquisition of a quadrupole ICPMS, a system which would allow for the quick and precise quantification of metals of interest. Additionally, when we are successful in bringing in funding for the acquisition of an ICPMS, I will also train students in the analysis of platinum group metal (platinum, gold, silver, etc) analysis, bringing a skill to our students that is currently out-sourced to a fee-for-service facility.

Concluding statement

I joined the UTEP family in January 2014 as Research Assistant Professor at the Department of Geological Sciences, and am excited to be part of to the unique journey that UTEP undergoes on its way to Tier 1 status as the first national research university serving a 21st century student demographic. I am convinced that my research plans, teaching interests, and commitment to the Department of Geological Sciences can contribute to this fantastic story of success. Go miners!