Mebrahtu F Weldeghebriel

Department of Geosciences, Princeton University, Princeton, NJ 08544, USA
(315) 944-7438 | mweldeg@princeton.edu | Google Scholar | Research Gate

EDUCATION

Binghamton University, State University of New York, Binghamton, NY **Aug 2016 – July 2022**
PhD Geological Sciences
Thesis: *Secular variability in major, minor, and trace element composition of Phanerozoic and Neoproterozoic seawater: evidence from fluid inclusions in marine halite*
Advisor: *Tim Lowenstein, Distinguished Professor*

Eritrea Institute of Technology (EIT), Asmara, Eritrea **Sep 2006 – Jul 2011**
BSc Geology
Thesis: *Sedimentology and Lithostratigraphy of the Evaporite Succession in the Danakil Depression: Colluli Area, Eritrea*
Advisor: *Nageshwar Dubey, Professor*

RESEARCH EXPERIENCE

Princeton University
NSF Postdoctoral Fellow **Sep 2024 – Present**
- Developing independent chronometer ($^{87}Sr/^{86}Sr$ ratios) for dating stratigraphically disturbed ice over 1 million years old in Antarctica's blue ice areas using LA-ICP-MS analysis of trapped sea-salts.
- Creating a high spatial resolution of the 2D elemental maps of impurity distribution and identifying stratigraphic orientation and thickness of layering in these old, folded ice.

Princeton University
Harry H. Hess Postdoctoral Research Fellow **Sep 2022 – Sep 2024**
- Improved analytical method for lithium isotope analysis of carbonates and fluid inclusions (FI) in halite using QQQ-ICP-MS.
- Investigated the behavior of lithium concentration and isotopic composition during evaporation of modern seawater.
- Reconstructed lithium isotope composition of Neoproterozoic and Phanerozoic seawater using FI in marine halite and past 3 billion years using dolostones.
- Conducted mass balance modeling to investigate the mechanisms that control long-term changes in seawater chemistry and the evolution of the global carbon cycle.

Binghamton University
Research Assistant **Aug 2021 – July 2022**
- Developed analytical technique to analyze major, minor and trace elements in fluid inclusions in halite using combined LA-ICP-MS and cryo-SEM-EDS.
- Documented the chemistry of ancient seawater using more than 2000 FI in halites from ~35 Phanerozoic evaporite basins.
- Investigated the drivers of long-term secular oscillations in seawater chemistry.
- Studied sedimentological and geochemical characteristics of recent evaporite sequences in Dead Sea, a modern analog to deep hypersaline basins in the geological record.

Eritrea Institute of Technology
Graduate Research Assistant **Sep 2011 – Jun 2015**
- Conducted petrographic and geochemical characterization of Neoproterozoic granitoid rocks in Eritrea (2013-2014).
- Prepared a seismological bulletin from regional seismic data phase readings from of 10 countries during the Eastern and Southern Africa Regional Seismological Workshop hosted in Asmara, Eritrea in 2013.
- Completed 6 survey-mode Global Positioning System (GPS) measurements from 2012 to 2014 in 15 GPS networks in Eritrea as part of the Eastern Mediterranean-Red Sea GPS-Geodynamics joint project with MIT to derive an improved velocity field for Danakil block and to monitor dynamics of the Afar triple junction.
- Deployed regional array of broadband seismometers across Eritrea and collected seismic data every 3 months to generate seismic tomography of the lithosphere beneath Eritrea and to monitor the recent Nabro volcanic eruption.

TEACHING EXPERIENCE

Binghamton University
Teaching Assistant **Aug 2016 – May 2021**
- Taught lab section of undergraduate and graduate courses to 15–30 students each semester for five years, including Geochemistry, Climatology and Paleoclimatology, Geology of the Solar System, Planet Earth, and Earth's Interior.
- Met with students during office hours and beyond to help them acquire greater knowledge for weekly assignments/labs.
- Graded lab reports and assignments.

Eritrea Institute of Technology
Graduate Teaching Assistant **Sep 2011 – Jun 2015**

- Lectured prerequisite courses: General Geology, Introduction to Rock-Forming Minerals, Introduction to Geophysics, and Geological Map Interpretation to 200+ undergraduate students.
- Developed full course materials for General Geology, including course outline, lessons, quizzes, and exams.
- Assisted faculty members with laboratory instructions for Geochemistry, Sedimentology, Stratigraphy and Paleontology.
- Coordinated and led three geology field camps annually for mapping of sedimentary, igneous, and metamorphic rocks.
- Mentored junior and senior undergraduate students in preparing geological reports.

PROFESSIONAL EXPERIENCE

Lithium Americas Corp.– Nevada, USA
Summer exploration intern **Jun 2021 – Sep 2021**

- Explored and characterized the geology of lithium resources in >25 sedimentary basins in the Western United States.
- Collected 1000s of rock and sediment samples for geochemical analysis and conducted field and desktop geological mapping
- Synthesized and interpreted field and laboratory data, and prepared reports.
- Discovered new sedimentary lithium deposits.

South Boulder Mines Ltd – Asmara, Eritrea
Exploration Geologist Intern **Jun 2010 – Mar 2011**

- Prepared a preliminary geological map of evaporites in Colluli Potash project, located in the Danakil Depression of Eritrea.
- Performed core logging of potash bearing evaporites and created stratigraphic columns and geological cross sections.
- Sampled potash intervals from diamond drill cores for geochemical analyses and assaying.
- Prepared undergraduate thesis using field geology, geochemical, well log, and bore hole data.

PUBLICATIONS

Peer Reviewed Papers

[9] Li, Y., Wang Y. Y., Murphy, J. G., **Weldeghebriel, M. F.,** Xiao, Y. 2024**.** Evaluating evaporites as potential archives of lake and seawater lithium isotopic ratio: An experimental study using various natural saline fluids. *Chem. Geol*. 122326. https://doi.org/10.1016/j.chemgeo.2024.122326

[8] Ajrhough, S., Boutarouine, H., Lowenstein, T. K., **Weldeghebriel, M. F.,** Xia, Z., El Arabi, E. H. 2024. Evaporites and red beds of a syn-rift Atlantic series: evidence of continental depositional environment (Berrechid sub-basin, Morocco). *J. Sediment. Res*. **94**, 750–767. https://doi.org/10.2110/jsr.2023.025

[7] Xia, Z., Li, S., Hu, Z., Bialik, O., Chen, T., **Weldeghebriel, M. F.**, ... Li, W., 2024. The evolution of Earth's surficial Mg cycle over the past 2 billion years. *Sci. Adv.* 10, eadj5474. https://doi.org/10.1126/sciadv.adj5474

[6] **Weldeghebriel, M. F.,** Lowenstein, T. K., 2023. Seafloor Hydrothermal Systems Control Seawater [Li^+]: Evidence from Fluid Inclusions, *Sci. Adv.* 9, eadf1605. https://doi.org/10.1126/sciadv.adf1605

[5] **Weldeghebriel, M. F.,** Lowenstein, T. K., Xia, Z., Li, W., 2023. Plate tectonic control of strontium concentration in Phanerozoic and Neoproterozoic seawater: Evidence from fluid inclusions in marine halite. *Geochim. Cosmochim. Acta* **346**, 165–179. https://doi.org/10.1016/j.gca.2023.02.009

[4] **Weldeghebriel, M. F.,** Lowenstein, T. K., García-Veigas J., Cendón, D. I., 2022. [Ca^{2+}] and [SO_4^{2-}] in Phanerozoic and terminal Proterozoic seawater from fluid inclusions in halite: The significance of Ca-SO_4 crossover points. *Earth Planet. Sci. Lett.* **594**, 117712. https://doi.org/10.1016/j.epsl.2022.117712

[3] Sendula, E., Gill, B.C., Rimstidt, J.D., Lowenstein, T.K., **Weldeghebriel, M.F.,** García-Veigas, J., Bodnar, R.J., 2022. Redox conditions in Late Permian seawater based on trace metal ratios in fluid inclusions in halite from the Polish Zechstein Basin. *Chem. Geol.* 596, 120794. https://doi.org/10.1016/j.chemgeo.2022.120794

[2] Lowenstein, T.K., **Weldeghebriel, M.F.,** Sirota, I., Eyal, H., Mor, M., Lensky, N.L., 2021. Criteria for the recognition of clastic halite: The modern Dead Sea shoreline. *Sedimentology* 68, 2253-2269. https://doi.org/10.1111/sed.12907

[1] **Weldeghebriel, M.F.,** Lowenstein, T.K., García-Veigas, J., Collins, D., Sendula, E., Bodnar, R.J., Graney, J.R., Cendón, D.I., Lensky, N.G., Mor, Z., Sirota, I., 2020. Combined LA-ICP-MS and cryo-SEM-EDS: An improved technique for quantitative analysis of major, minor, and trace elements in fluid inclusions in halite. *Chem. Geol.* 551, 119762. https://doi.org/10.1016/j.chemgeo.2020.119762

In Review and In Preparation

[1] **Weldeghebriel** et al. A 3-Billion-Year Lithium Isotope Record from Marine Dolostones. *In prep.*
[2] **Weldeghebriel** et al. Precise determination of lithium isotope ratio of fluid inclusions in halite using QQQ-ICP-MS in cool plasma mode. *In prep.*
[3] **Weldeghebriel** et al. Reconstructing the secular evolution of lithium isotope composition of Phanerozoic and Neoproterozoic seawater from marine halite. *In prep.*
[4] **Weldeghebriel** et al. Secular variability in major, minor, and trace element composition of Phanerozoic and Neoproterozoic seawater: Implications for reconstructing drivers of seawater secular variability and climate. *In prep.*
[5] **Weldeghebriel** et al. Lithium: a fingerprint to magmatic-hydrothermal source waters into sedimentary basins. *In prep.*
[6] **Weldeghebriel** et al. Coupling halite deposition in the Dead Sea to environmental conditions. *In prep.*
[7] Jurikova et al. Reconstructing the secular evolution of boron isotope composition of seawater from evaporites. *In prep.*

Conference Proceedings (oral and poster presentations) **Denotes invited. #Denotes convener*

[1] ***Weldeghebriel, M. F.,** Lowenstein, T. K., Murphy, J. G., Jurikova, H., Rae, J. W.B., Niespolo, E. M., Higgins, J. A. Secular Variations in Phanerozoic Seawater Lithium and Links to Earth's Climate States and the Carbon-Silicate Cycle. Gordon Research Conference 2025, 16-22 August, Maine, USA.

[2] **#Weldeghebriel, M. F.,** Xia, Z., Li, W., Lonsdale, M., Smith, E.F., Blättler, C., Nadeau, M., Murphy, J. G., Niespolo, E. M., Higgins, J. A., A 3-Billion-Year Lithium Isotope Record from Marine Dolostones. Goldschmidt 2025, 6-11 July, Prague, Czech Republic.

[3] ***Weldeghebriel, M. F.,** Lowenstein, T. K., Murphy, J. G., Jurikova, H., Rae, J. W.B., Niespolo, E. M., Higgins, J. A. Secular variation of lithium concentration and isotopic composition of Phanerozoic and Neoproterozoic seawater: Evidence from fluid inclusions in marine. Goldschmidt 2024, 18-23 August, Chicago, USA.

[4] **#Weldeghebriel, M. F.,** Lowenstein, T. K., Higgins, J. A. Variability in strontium and lithium composition of ancient seawater from fluid inclusions in halite—implications for reconstructing drivers of seawater secular variability. EGU 2024, 14–19 April, Vienna, Austria.

[5] **Weldeghebriel, M. F.,** Murphy, J.G., Jurikova, H., Lowenstein, T.K., Rae J. W.B., Niespolo, E. M., Higgins, J. A., Reconstructing the secular evolution of lithium isotope composition of Phanerozoic and Neoproterozoic seawater from marine halite. GSA 2023, 15-18 October, Pittsburg, USA.

[6] **Weldeghebriel, M. F.,** Murphy, J.G., Jurikova, H., Lowenstein, T.K., Rae J. W.B., Niespolo, E. M., Higgins, J. A., Reconstructing the secular evolution of lithium isotope composition of seawater from marine halite. Goldschmidt 2023, 9-14 July, Lyon, France.

[7] **Weldeghebriel, M. F.,** Lowenstein, T.K., Higgins, J. A., Variability in strontium and lithium concentration of ancient seawater from fluid inclusions in halite—implications for reconstructing drivers of seawater secular variability. Chapman hydrothermal conference 15-19 May 2023, Agros, Cyprus.

[8] **Weldeghebriel, M. F.,** Lowenstein, T.K., Sirota, I., Eyal, H., Mor, Z., Lensky, N., Coupling Halite Deposition in the Dead Sea to Environmental Conditions. AGU Fall Meeting, 13-18 December 2021, New Orleans, Louisiana, USA.

[9] Jurikova, H., Rae, J. W., Gázquez, F., Sendula, E., Bodnar, R., **Weldeghebriel, M.,** Lowenstein, T. (2021). Reconstructing the secular evolution of boron isotope composition of seawater from evaporites. Goldschmidt 2021, 4-9 July, Virtual.

[10]Weldeghebriel, M. F., Lowenstein, T. K., 2019. Secular Variability of Phanerozoic Seawater Strontium: Evidence from Fluid Inclusions in Marine Halite. AGU Fall Meeting, 9-13 December 2019, San Francisco, California, USA. http://adsabs.harvard.edu/abs/2019AGUFMPP51E1411W.

[11]Weldeghebriel, M. F., Lowenstein, T. K., Demicco, R. V., Graney, J. R., Collins, D., Veigas, J. G., ... & Sendula, E., 2019. Seafloor hydrothermal systems control seawater chemistry: evidence from fluid inclusions in halite. GSA Annual Meeting, 22-25 September, Phoenix, Arizona, USA. https://doi.org/10.1130/abs/2019am-335157.

[12]Weldeghebriel, M. F., Lowenstein, T. K.,2018. Major, minor and trace element evolution of Phanerozoic seawater. GSA Northeastern Section-53rd Annual Meeting, 18-20 March 2018, Burlington, Vermont, USA. https://doi.org/10.1130/abs/2018ne-311328.

[13] **Weldeghebriel, M. F.,** 2014. Sedimentation and lithostratigraphic succession of evaporites in the Danakil Depression, Colluli, Eritrea. 3rd World Young Earth Scientists Congress, 11-14 August 2014, Dar es Salaam, Tanzania.

[14]Weldeghebriel, M. F., Kiflai, M. E., 2014. A proposed-detailed investigation on petrography, geochemistry, and geochronology of Neoproterozoic granitoid rocks in Dekemhare Area, Eritrea. 3rd World Young Earth Scientists Congress, 11-14 August 2014, Dar es Salaam, Tanzania.

HONORS AND AWARDS

- Harry H. Hess Postdoctoral Research Fellow at Princeton University (September 2022–present)
- Graduate Student Excellence Award in Research, Binghamton University (March 2021).
- Graduate Student Research Award for excellence in research proposal, Mineralogy, Geochemistry, Petrology and Volcanology (MGPV) Division of the Geological Society of America (April 2019).
- Research Assistantship Scholarship Award (August 2021–August 2022)
- Teaching Assistantship Scholarship Award (August 2016–May 2021)
- Provost Doctoral Summer Fellowship, Binghamton University (2016–2020).
- Türkiye Scholarship, Dokuz Eylül University, Turkey (July 2015).
- Outstanding Student and Gold Medal Winner, College of Science, Eritrea Institute of Technology (July 2011).

GRANTS RECEIVED

- NSF Office of Polar Programs Postdoctoral Research Fellowship (OPP 2420291), $359,487 (2024).
- Received three competitive graduate student research grants to conduct my PhD research at Binghamton University from:
    1. Geological Society of America (GSA), $2,500 (2019).
    2. Society of Economic Geologists Foundation (SEGF), $4,700 (2018).
    3. American Association of Petroleum Geologists Foundation (AAPGF), $3,000 (2018).
- Received graduate school travel grant from Binghamton University to present papers at the GSA ($900, 2019) and AGU ($920, 2021) annual meetings.
- Received research grant from Eritrean Research Fund to study Petrography and Geochemistry of granitoid rocks in Dekemhare area, Eritrea, $12,500 (2014).

AFFILIATIONS

- Geological Society of America (GSA), American Geophysical Union (AGU), Society of Economic Geologists (SEG), American Association of Petroleum Geologists (AAPG), European Association of Geochemistry (EAG), Eastern and Southern Africa Regional Seismological Working Group (ESARSWG).

SKILLS AND COURSES

Software: MATLAB, SILLS, Iolite, EQL-EVP, PHREEQC, Frezchem, Geochemist's Workbench, ArcGIS Pro, Adobe Illustrator, MS Office.
Technical: LA-ICP-MS, MC-ICP-MS, ICP-OES, XRD, Microprobe, Gravity column, Fluid inclusion heating/freezing stage, Fluid inclusion and Brine Geochemistry, Evaporite Sedimentology, Seawater Chemistry and modeling, Climate.
Foreign Languages: English, Turkish, Amharic, Tigrinya (Mother tongue)

REFERENCES

Tim Lowenstein, Distinguished Professor
Department of Geological Sciences and Environmental Studies
Binghamton University
(607) 765-8962, lowenst@binghamton.edu

John Higgins, Professor
Director of Graduate Studies
Department of Geosciences
Princeton University
jahiggin@princeton.edu

Elizabeth Niespolo, Assistant Professor
Department of Geosciences
Princeton University
niespolo@princeton.edu

Joseph Graney, Professor
Department of Geological Sciences and Environmental Studies
Associate Director, Center for Integrated Watershed Studies
Binghamton University
(607) 777-6347, jgraney@binghamton.edu

David M. Jenkins, Professor
Department of Geological Sciences and Environmental Studies
Binghamton University
(607) 777-2736, dmjenks@binghamton.edu

Robert V Demicco, Professor
Department of Geological Sciences and Environmental Studies
Binghamton University
(607) 759-6226, demicco@binghamton.edu

Thomas R. Benson, Ph.D.
Lead Global Exploration Geologist
Lithium Americas Corporation
(609) 658-3358, tom.benson@lithiumamericas.com