

Alexander Kirshen
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Boston, Massachusetts

EDUCATION

University of Massachusetts Amherst (Amherst, MA | September 2019 - December 2021)

- B.S. Environmental Science, B.A. Geology (Dual Degree)
- Commonwealth Honors College, summa cum laude, Dean's List all semesters, Geology Outstanding Senior Award, Environmental Science Outstanding Junior Award
- Honors Thesis: Hydrostratigraphic analysis and paleoclimate records of evaporite sediments in the transition zone of the Salar de Atacama, Chile

University of Vermont (Burlington, VT | August 2016 - May 2018)

- Grossman School of Business, Dean's List all semesters, member of Club Basketball team

SOFTWARE SKILLS

- Python, MATLAB, Google Earth Engine, ArcGIS Pro, Leapfrog Geo, Microsoft Excel, Adobe Illustrator, MODFLOW 6, Groundwater Modeling System, AQTESOLV, COMSOL Multiphysics, Oasis montaj, Geopsy

RELEVANT EMPLOYMENT AND RESEARCH

Hydrogeology and Geochemistry Research Group, with Dr. David Boutt & Dr. Lee Ann Munk (University of Massachusetts Amherst & University of Alaska Anchorage)

- Research Fellow (November 2022 - Present)
- Research Technician (December 2021 - November 2022)
- Undergraduate Researcher (December 2020 - December 2021)
- Research Group Overview: 1) Studying sustainability of lithium mining and genesis of lithium brine and clay ore deposits using hydrogeology, isotope geochemistry, and geophysics, and 2) investigating potential for saltwater intrusion and groundwater flooding from changes in terrestrial recharge and sea level rise in New England
- Participated in and led weekly meetings with consultants, governmental agencies, local organizations, and mining companies to present project updates and discuss future goals
- Assessed water availability for 28 potential lithium producing basins in the Lithium Triangle, South America using basin-scale calculations of groundwater recharge, streamflow, human water consumption, and environmental flow requirements (BMW and BASF funded project with first-author publication in preparation)
- Integrated radioisotope data (^3H) and MODPATH particle tracking results from Clayton Valley, Nevada to constrain sources and age of freshwater within the basin (poster presentation at GSA Connects 2022)
- Collaborated with consulting company to understand the water budget for Clayton Valley, Nevada by calculating evapotranspiration (based on depth to water and vegetation type), streamflow, interbasin flow, and groundwater recharge
- Integrated 60 core logs, geophysics (TEM, gravity, passive seismic), and surficial geology to develop 1,400 km² 3D geologic model with 12 hydrogeologic units of the Salar del Hombre Muerto, Argentina in Leapfrog Geo and ArcGIS Pro (BMW and BASF funded project with publication in preparation)
- Developed groundwater model for Municipal Vulnerability Preparedness (MVP) funded project by 1) integrating Lidar DEM, bathymetry, and terrestrial and offshore bedrock elevations to build 600 km² onshore-offshore geologic model of the Plymouth-Carver aquifer with 30 hydrogeologic units using Leapfrog Geo, ArcGIS Pro, Groundwater Modeling System, and Python, and 2) creating 3D variable-density groundwater flow and transport model in MODFLOW 6 of the Plymouth-Carver aquifer with transient projected well pumping, terrestrial recharge, and sea level rise through 2100 based on future climate scenarios to map the geometry of the freshwater-saltwater interface and identify high-risk areas for saltwater intrusion with Groundwater Modeling System and Python
- Created Hydrogeologic Atlas of Massachusetts with maps of hydraulic conductivity, transmissivity, water table elevation, aquifer yield, storage properties, and water table ratio for Massachusetts Department of Conservation and

Recreation funded project based on surficial geology, depth-to-bedrock, water table elevation, and hydraulic properties which will be hosted on ArcGIS public server

- Analyzed geophysical data including 1) HVSR data from Argentina and Alaska to estimate depth-to-bedrock with Geopsy, and 2) airborne electromagnetic data from Clayton Valley, Nevada by identifying electrical conductivity signatures of freshwater and brine in different lithologies to map the geometry of the brine-freshwater interface and estimate freshwater inflow thickness using Oasis montaj and Python

Honors College Undergraduate Thesis: Hydrostratigraphic analysis and paleoclimate records of evaporite sediments in the transition zone of the Salar de Atacama, Chile, with Dr. David Boutt (University of Massachusetts Amherst)

- Undergraduate Researcher (February - December 2021)

- Integrated geophysical data (borehole nuclear magnetic resonance, gamma ray logs, TEM) and lithologic core logs to characterize the hydrostratigraphic architecture of a key inflow zone using MATLAB, Adobe Illustrator, and ArcGIS Pro
- Performed spectral analysis on gamma ray logs in MATLAB to identify the longest paleoclimate record in the Altiplano-Puna region (>200,000 years) and determine that precession orbital cycles are likely the key driver of climate changes on 100,000-year timescales

Tidewater Dynamics and Oceanographic Studies in Kongsfjord, Svalbard, with Dr. Julie Brigham-Grette (University of Massachusetts Amherst)

- Undergraduate Researcher (July 2021)

- Studied Kongsvegen and Kronebreen glaciers with 4-person fieldwork team in Ny-Ålesund, Svalbard
- Conducted bathymetric surveys, estimated sediment plume velocity, captured drone footage, and measured optical backscatter and CTD (conductivity, temperature, depth) profiles to collect data on sedimentation rates, timing and extent of sediment plumes, and presence of warm Atlantic water entering the fjord
- Processed CTD data using Sea-Bird software and created all maps and plots for GSA Connects 2021 poster

Weston & Sampson (Reading, Massachusetts)

- Hydrogeology Assistant (May - August 2020)

- Installed pressure transducers in 17 monitoring wells, measured water levels at all wells during pumping test, processed transducer data, and produced all plots for final pumping test report
- Investigated 2 pumping test reports (>400 pages) and compiled borehole lithology data from 15 wells to input into Leapfrog Works for 3D aquifer interpretation
- Wrote sections of action grants and engaged in public outreach for a Municipal Vulnerability Preparedness flooding project

Independent Study: Tidmarsh Wetland Restoration Project, with Dr. Christine Hatch (University of Massachusetts Amherst)

- Undergraduate Researcher (January - May 2020)

- Compiled 4 years of pressure transducer data from 19 piezometers to calculate hydraulic gradient
- Organized 4 years of stream measurements to generate stage vs. discharge rating curves

Comunidad Educativa Lux Mundi (Santo Domingo, Dominican Republic)

- Head Teacher and Coach (January - May 2019)

- Taught 4th, 5th, and 6th grade literature (20 periods per week) as first teacher from the United States
- Coached 10-player high school basketball with daily practices and weekly games

FIELDWORK RELATED TO ABOVE PROJECTS

Clayton Valley and Fish Lake Valley, Nevada (January 2022, October 2022, & April 2023)

- Designed and led sample campaigns of brine aquifers (50 wells) and freshwater inflows (12 springs) at Albemarle Silver Peak Lithium Mine to analyze for major and minor ions, tritium (³H), O and H stable isotopes, and Li and Sr isotopes to characterize sources and age of water

- Collected temperature, specific conductance, and pH data with YSI instrument for all brine and freshwater samples to map 3D distribution of temperature and salinity within aquifers
- Mapped clay and ash sections to create ~35-meter stratigraphic columns, collected ash samples to date with $^{40}\text{Ar}/^{39}\text{Ar}$ and U-Pb methods, and collected clay samples to run for O and H stable isotopes on carbonates to constrain timing of paleolake environments and sources of lithium to clays
- Logged 200-meter core of ashes, clays, and sands and collected ash and clay samples for analysis mentioned in previous bullet point

Salar del Hombre Muerto & Salar de Carchi Pampa, Catamarca, Argentina (June 2022)

- Measured stream discharge with OTT MF pro flow meter, collected stream and groundwater samples to study groundwater-surface water interactions, and investigated carbonate and ignimbrite outcrops in lithium producing basins
- Recorded seismic noise with three-component seismometer (Tromino instrument) to process with horizontal-to-vertical spectral ratio method (HVSr) to characterize basin-fill thickness
- Explored well pads, locations of future drilling, and water sampling locations with private company within their mineral claim to further understand their project goals

NOAA Kasitsna Bay Laboratory, Kachemak Bay, Alaska (May 2022)

- Measured stream discharge with OTT MF pro and acoustic doppler current profilers (ADCP), and collected stream samples to characterize stream chemistry in glacierized catchments
- Recorded seismic noise with three-component seismometer (Tromino instrument) to process with HVSr method to characterize basin-fill thickness

Ny-Ålesund Norwegian Polar Institute Research Station, Svalbard, Norway (July 2021)

- Studied glacier and ocean processes by traveling 6 miles daily (20 days total) to Kongsvegen and Kronebreen tidewater glaciers on an 18-foot boat with 4-person research team
- Conducted bathymetric surveys, estimated sediment plume velocity, captured drone footage, and measured optical backscatter and CTD (conductivity, temperature, depth) profiles

PUBLICATIONS AND MANUSCRIPTS

1. Moran, B. J., Boutt, D. F., McKnight, S. V., Jenckes, J., Munk, L. A., Corkran, D., & **Kirshen, A.** (2022). Relic groundwater and prolonged drought confound interpretations of water sustainability and lithium extraction in arid lands. *Earth's Future*, 10(7), e2021EF002555.
2. **Kirshen, A.** (2021). Hydrostratigraphic analysis and paleoclimate records of evaporite sediments in the transition zone of the Salar de Atacama, Chile. Unpublished Undergraduate Honors Thesis, University of Massachusetts Amherst.
3. Corkran, D., Boutt, D., Munk, L.A., Moran, B.J., McKnight, S., **Kirshen, A.**, & Jenckes, J. (in review). Constraints on groundwater abstraction impacts in lithium brine systems. *Nature Geoscience*.
4. Corkran, D., Boutt, D., Munk, L.A., Moran, B.J., **Kirshen, A.**, McKnight, S., Jenckes, J., & Russo, A. (in prep). Resilient brine and freshwater abstraction for lithium resources in the Salar del Hombre Muerto basin.
5. **Kirshen, A.**, Moran, B.J., Boutt, D., Jenckes, J., McKnight, S., Russo, A., Munk, L.A., Corkran, D., & Bresee, M. (in prep). Water availability in the Lithium Triangle, South America. *Nature Sustainability*.
6. McKnight, S., Jenckes, J., Boutt, D., Moran, B.J., Munk, L.A., Corkran, D., & **Kirshen, A.** (in prep). Hydrologic signatures on surface water complexes in the Altiplano. *Nature Water*.

TECHNICAL REPORTS

1. Corkran, D., Boutt, D., **Kirshen, A.**, King, R. (in prep). Massachusetts Groundwater Flooding and Water Table Rise Assessment. Report in preparation for submission to Massachusetts Department of Conservation and Recreation.
2. **Kirshen, A.**, Boutt, D., Corkran, D., Moran, B.J., Lambardo, C., & King, R. (2023). Saltwater Intrusion Vulnerability Assessment in Plymouth, MA - Compounding effects of Sea Level Rise on Water Quality and Aquifer Sustainability. Report submitted for Municipal Vulnerability Preparedness project in Plymouth, MA.

3. King, R., Boutt, D., **Kirshen, A.**, Munk, L.A. (2023). Albemarle Clayton Valley Airborne Electromagnetic Survey Interpretation. Report submitted to Albemarle Corporation.
4. Boutt, D., Munk, L.A., Moran, B., Corkran, D., McKnight, S., Jenckes, J., **Kirshen, A.**, Russo, A. (2022). Evaluating Hydrological Impacts of Brine Operations at Salar del Hombre Muerto, Argentina. Report submitted to BASF and BMW.
5. Boutt, D., Munk, L.A., Moran, B., Corkran, D., McKnight, S., Jenckes, J., **Kirshen, A.** (2022). Investigating the consumption of water through the production cycle of lithium. Report submitted to BASF and BMW.

CONFERENCE ABSTRACTS

1. Corkran, D., Boutt, D., Munk, L.A., Moran, B., McKnight, S., & **Kirshen, A.** (2022, October). Modeling potential impacts of lithium brine mining on groundwater discharge at Salar del Hombre Muerto, Argentina. GSA Connects 2022 poster presentation.
2. **Kirshen, A.**, Boutt, D., Munk, L.A., Moran, B., McKnight, S., Corkran, D., & Jenckes, J. (2022, October). Sources, age, and geochemistry of fresh groundwater and lithium brine in Clayton Valley, Nevada. GSA Connects 2022 poster presentation.
3. McKnight, S., Jenckes, J., Boutt, D., Munk, L.A., Moran, B., Corkran, D., & **Kirshen, A.** (2022, October). Hydrologic Signatures on Lagoon Complex and Wetland Inundation in the Lithium Triangle of the Altiplano-Puna Region. GSA Connects 2022 poster presentation.
4. Russo, A., Jenckes, J., Munk, L.A., Boutt, D.F., & **Kirshen, A.** (2022, October). A multidisciplinary approach to characterizing ice-distal glaciofluvial deltas to gain insight of submarine groundwater discharge from high-latitude active margins. GSA Connects 2022 poster presentation.
5. Boutt, D., Moran, B., McKnight, S., Jenckes, J., Munk, L.A., Corkran, D., & **Kirshen, A.** (2022, September). Drivers of hydrological change in the Salar de Atacama Watershed. Water Congress 2022 poster presentation.
6. Corkran, D., Boutt, D.F., Munk, L.A., Moran, B., McKnight, S.V., & **Kirshen, A.** (2022, June). Modeling the impacts of lithium brine mining on water resources in South American Salars. MODFLOW and More 2022 poster presentation.
7. McKnight, S.V., Jenckes, J., Boutt, D.F., Munk, L.A., Moran, B., Corkran, D., & **Kirshen, A.** (2022, June). Hydrologic Signatures on Lagoon Complex and Vegetated Wetland Inundation in the Lithium Triangle of the Altiplano-Puna Region. *Frontiers in Hydrology* 2022.
8. Moran, B., Boutt, D.F., Munk, L.A., Jenckes, J., McKnight, S.V., Corkran, D., & **Kirshen, A.** (2022, June). Opportunities for Optimizing Lithium Production. 2022 NORA Collaboration Days, UMass Amherst.
9. Munk, L.A., Boutt, D., Moran, B.J., McKnight, S., Jenckes, J., Corkran, D., & **Kirshen, A.** (2022, May). Lithium Water Sustainability Consortium. The Energy Transition Symposium at UMass Amherst 2022 poster presentation.
10. Brigham-Grette, J., Goldner, M., McKeon, K., & **Kirshen, A.** (2021, October). Tidewater margin influence of meltwater plumes and sedimentation at the head of Kongsfjord, Svalbard. GSA Connects 2021 poster presentation.
11. Munk, L.A., Boutt, D., Moran, B.J., McKnight, S., Jenckes, J., Corkran, D., & **Kirshen, A.** (2021, May). Facilitating Sustainable Energy Transition: Lithium Brine Extraction and Impacts on Freshwater in South America. The Energy Transition Symposium at UMass Amherst 2021 poster presentation.