Andrew B. Foerder

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RESEARCH INTERESTS

Extracting quantitative measurements from remote sensing imagery where ground truth is scarce, using machine learning and computer vision. Current work spans automated landform detection at survey scale, paleoclimate inference from surface morphology, and the evaluation design that determines what such measurements can support.

EDUCATION

Ph.D., Earth, Environmental & Planetary Sciences — University of Tennessee, Knoxville expected 2027

Dissertation: Machine learning and computer vision for automated landform detection and paleoclimate inference in Mars orbital imagery. Advisor: Dr. Bradley J. Thomson.

Coursework: Remote Sensing for Geoscientists; GIS for Geoscientists; Graduate Seminars in Geochemistry, Biosignatures, and Impact Cratering; Volcanology; Water Sustainability & Climate.

M.Sc., Earth & Planetary Sciences — University of Hawai'i at Mānoa 2020

Thesis: Chemical Alteration and Soil Provenance of Polar Desert Sediments from the McMurdo Dry Valleys, Antarctica: An Analog for Alteration Processes on Mars.

B.A., Geology–Biology — Brown University 2018

RESEARCH APPOINTMENTS

Graduate Research Assistant — University of Tennessee, Knoxville Aug 2023 – present

- Built an end-to-end deep learning pipeline that detects thermal contraction polygons in HiRISE imagery and classifies fracture-junction geometry (T, Y, X, N) as a quantitative paleoclimate proxy; best model labels 84% of junctions correctly and resolves terrain types from as few as 25–50 junctions.
- Showed where the principle of terrestrial analogy survives computational transfer, and where it fails, by training segmentation models on three Earth landform classes (arctic tundra polygons, inverted channels, valley networks) and evaluating them on Mars orbital imagery.
- Building cloud infrastructure for a ~55 TB HiRISE corpus: GPU Spot fleets on AWS Batch, windowed Cloud-Optimized GeoTIFF reads, a NASA PDS STAC client for programmatic footprint discovery, and a containerized CUDA runtime.
- Conducting a pre-registered assessment of Mars dust storm predictability, establishing detection floors for precursor signals given the sparsity of the modern observational record.

Temporary Researcher, Tolbert Group — CIRES, University of Colorado Boulder Aug 2020 – Nov 2021

- Investigated deliquescence and efflorescence of Antarctic soils as a driver of recurring slope lineae, with implications for Mars; ran humidity-controlled experiments and advised a chemistry-focused team on geologic and geochemical context.

Graduate Research Assistant — Hawai'i Institute of Geophysics & Planetology Jan 2019 – Jul 2020

Advisor: Dr. Peter A. J. Englert.

- Led retrospective studies using Antarctic Dry Valley soils as Mars analogues, comparing rover observations against field and laboratory datasets using reproducible Python workflows.

Volunteer Researcher — University of Washington Jun 2015 – Aug 2015

- Supported CRISPR-Cas9 research; maintained data completeness and protocol adherence.

PUBLICATIONS

Peer-reviewed journal articles

Foerder, A. B., Magocs, B. L., Thomson, B. J., and Bhidya, H. (under review). *Toward paleoclimate mapping on Mars by detecting and classifying fracture junctions with machine learning*. Journal of Geophysical Research: Machine Learning and Computation.

Burton, Z. F. M., Koeberl, C., Bishop, J. L., Englert, P. A. J., Smith, M. P., **Foerder, A. B.**, and Gibson, E. K. (2025). *Controls on cold-climate critical minerals: regolith-hosted REE at three polar desert salt ponds (McMurdo Dry Valleys, Antarctica)*. Cold Regions Science and Technology 239: 104583. doi:10.1016/j.coldregions.2025.104583

Foerder, A. B., Englert, P. A. J., Bishop, J. L., Koeberl, C., Burton, Z. F. M., Patel, S., and Gibson, E. K. (2024). *Don Juan Basin, Antarctica: A chemically altering environment with martian analog potential*. American Mineralogist 109: 682–700. doi:10.2138/am-2022-8779

Manuscripts in preparation

Foerder, A. B., Thomson, B. J., and Magocs, B. L. (in preparation). *Earth-to-Mars transfer learning for automated detection of volatile-influenced landforms*. Target: Icarus / JGR: Planets.

Thesis

Foerder, A. B. (2020). *Chemical Alteration and Soil Provenance of Polar Desert Sediments from the McMurdo Dry Valleys, Antarctica: An Analog for Alteration Processes on Mars*. M.Sc. thesis, University of Hawai'i at Mānoa.

Conference abstracts and presentations

Foerder, A. B., Thomson, B. J., and Magocs, B. L. (2026). *Earth-to-Mars transfer learning: a novel method for the automatic detection of volatile-influenced landforms on Mars*. 57th Lunar and Planetary Science Conference, abstract #1717 (poster). Bibcode 2026LPICo3160.1717F.

Foerder, A. B., Englert, P. A. J., Bishop, J. L., and Szynkiewicz, A. (2023). *Sulfate mineralogy and concentrations of Don Juan Basin, Antarctica: a geochemical analog for aqueously altered environments on Mars*. American Geophysical Union Fall Meeting, abstract #1259082 (poster). Bibcode 2023AGUFM.P53D2785F.

Foerder, A. B., Englert, P. A. J., Koeberl, C., Bishop, J. L., and Gibson, E. K. (2023). *A gradient of chemical alteration in Don Juan Basin, Antarctica, and applications to Mars*. 54th Lunar and Planetary Science Conference, abstract #2368 (poster).

Foerder, A. B., Englert, P. A. J., Koeberl, C., Bishop, J. L., and Gibson, E. K. (2023). *Accounting for salt dilution in the chemical index of alteration: applications to Don Juan Basin, Antarctica, and Mars*. 54th Lunar and Planetary Science Conference, abstract #2418 (poster). Bibcode 2023LPICo2806.2418F.

Englert, P. A. J., Bishop, J. L., **Foerder, A. B.**, Bailey, A., Burton, Z. F. M., Patel, S., Koeberl, C., and Gibson, E. K. (2021). *Weathering and chemical alteration in Wright Valley, Antarctica, as an analog for alteration on Mars*. Geological Society of America Connects, paper 179-11 (poster). doi:10.1130/abs/2021AM-364655

Foerder, A. B., Englert, P. A. J., Bishop, J. L., Koeberl, C., and Gibson, E. K. (2020). *Rare earth element abundances and chemical alteration in microenvironments of the McMurdo Dry Valleys*. 51st Lunar and Planetary Science Conference, abstract #2298 (poster). Bibcode 2020LPI....51.2298F.

GRANTS & FELLOWSHIPS

NASA FINESST — Future Investigators in NASA Earth and Space Science and Technology 2026 – 2027

Submitted as Future Investigator; decision pending. Proposed a planet-wide deployment of the fracture-junction detection and classification pipeline for martian mid-latitude paleoclimate mapping.

RESEARCH SOFTWARE

TYXN Labeler — annotation tool for fracture-junction labeling 2025

Built to remove labeled data as the binding constraint on junction classification; produced the hand-labeled training set used in the JGR manuscript.

TEACHING

Graduate Teaching Assistant — University of Tennessee, Knoxville Aug 2023 – present

EEPS 450, Landscapes: Earth and Elsewhere (upper division) • EEPS 101, The Dynamic Earth • EEPS 103, The Earth's Environments. Lead laboratory sections, grade, hold office hours, and develop supplementary materials.

Graduate Teaching Assistant — University of Hawai'i at Mānoa 2019

GG 309, Sedimentology & Stratigraphy.

Student-Athlete Tutor — University of Hawai'i at Mānoa 2018
Introductory geology and oceanography; planned bi-weekly exam preparation sessions.

MENTORING

Undergraduate research mentor — FRAF program, University of Tennessee 2025 – present
Supervising an undergraduate researcher in scientific applications of machine learning.

TECHNICAL SKILLS

Machine learning PyTorch; U-Net and U-Net++; Mask R-CNN (Detectron2); segmentation_models_pytorch; SAM fine-tuning; DINOv3 and Vision Transformers; custom architectures, losses, and samplers; scikit-learn; XGBoost; stacking ensembles; Optuna

Evaluation and statistics Nested and grouped cross-validation; probability calibration; simulation-based power analysis; data-leakage detection; pre-registration

Remote sensing and geospatial HiRISE and CTX orbital imagery; rasterio; Cloud-Optimized GeoTIFF; NASA PDS STAC API; scikit-image; ArcGIS Pro

Computing Python; AWS Batch and S3; Docker (multi-stage CUDA); Git; reproducible workflow design

Laboratory and field Subsurface geophysical visualization techniques such as Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR)

PROFESSIONAL DEVELOPMENT & ACTIVITIES

NASA Science Mission Directorate AI/ML Workshop (2024).

Coursework and certifications: Deep Learning Specialization; Convolutional Neural Networks; Neural Networks & Deep Learning; Advanced Learning Algorithms; Structuring Machine Learning Projects; Deep Learning for Images with PyTorch; Transformer Models with PyTorch; Remote Sensing & Geospatial Analysis.

NCAA Division I distance runner, four years (Brown University).