

Daniel Wells, Ph.D.

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EDUCATION

University of Utah, Salt Lake City, UT, 2018 - 2023

Doctorate in Geophysics - Advisor: Dr. Kristine Pankow

- 4.00 GPA
- Treasurer of university organization - Inclusive Earth
- Coursework: Bayesian Machine Learning, Seismic Sources, Inversion Theory, Geodynamics, Data Science, Signal Processing, Seismology, Statistical Applications to GeoScience (Machine Learning)
- Wells, D. E. (2023). *Examining Shallow Crustal Structure in the Intermountain West Using Portable Seismic Arrays*. (Doctoral dissertation, The University of Utah).

Western Washington University, Bellingham, WA, 2012 - 2016

Bachelors in Geophysic - Advisor: Dr. Jackie Caplan-Auerbach

- 3.81 GPA
- Mathematics and Spanish Minors

PROFESSIONAL EXPERIENCE

Idaho National Laboratory, Idaho Falls, ID, 2024 - 2026

Research Data Scientist

Project Summaries:

- **Chimera - a framework for accessible and automatic application of AI and ML**
 - Developed flexible auto-encoders and dimensionality reduction wrappers to facilitate rapid application of AI to flexible input data
- **Geometallurgy of Rare Earth Elements for Novel Refinement (GREENR)**
 - Compiled global monazite data to work towards a universal data format and style
 - Addressed fundamental problems with rare earth elements and machine learning - insufficient, high quality data.
 - Use supervised machine learning to predict categorical monazite type
- **Multiphysics Stimulation for Geological Hydrogen Production**
 - Worked with a team to produce physics-based simulations and laboratory experiments for accelerating subsurface serpentinization for hydrogen production.
 - Use physics informed neural networks to help explore parameter space for optimal conditions (temperature, grain size, etc).
- **A Machine Learning Pipeline for Portable Detection, Classification, and Analysis of Unknown Wireless Signals**
 - Programmed and used convolution-based GANs for recognition of wireless signals that are unknown from a large database of signals.
 - Used a transformer based architecture to classify known signals among known classes of signals.
 - Implemented models into portable computers for field use.
- **Deep Learning Anomaly Detection for Cyber Security**
 - Used various deep learning and unsupervised learning techniques to identify anomalous network communication activity within INL infrastructure.
 - Worked towards implementation of models into production environments.
- **Detecting Unclassified Electromagnetic Signals for Secure Wireless Communication Using Open Set Recognition**
 - Used auto-encoders, generative adversarial networks (GANs), and multi-class convolutional networks to identify unseen wireless signals using multiple domain feature representation and used outlier based data representation to improve performance.
 - Explored various methodologies to improve the capability of the network to identify 'open-set' (unknown) signals while correctly identifying known signals.

United States Geological Survey, Golden, CO, 2023 - 2024

Mendenhall Postdoctoral Research Geophysicist

- Towards implementation of deep learning seismic phase pickers into the daily operations of the National Earthquake Information Center (NEIC)

- Generated an ML-based code base to identify global seismic P and S phases reliably, consistently, and accurately.
- Built on the work of existing deep learning models and modified the training methods and architecture to achieve better consistency.
- Examined the limitations of using a deep learning model compared to existing methodology.
- Worked with a team of scientists to implement a deep learning model into daily operations.

University of Utah, Salt Lake City, UT, 2018–2023

Graduate Geophysics Research Assistant

- **Evidence for Interaction of Wasatch Fault Segments at Depth from the Magna Earthquake Sequence**
 - Examined the seismicity associated with each of the Wasatch Fault segment boundaries.
 - Generated focal mechanisms for the 2019 Bluffdale sequence in the SLC valley and examined paleoseismic data and mapped surface traces of the Wasatch Fault at or near the segment boundaries.
 - Concluded that the segment boundaries drive much of the local seismicity and that the deformation zone associated with each boundary may inhibit multi-segment rupture.
- **The Feasibility of Incorporating a 3D Velocity Model Into Earthquake Location Around Salt Lake City, UT Using a Physics Informed Neural Network**
 - Tested a recurrent neural network architecture to learn a seismic velocity model and reproduce: (1) seismic velocity and (2) seismic travel times between any two physical points within a model.
 - Systematically explored accuracy and limitations of neural networks for use in an active seismic network.
 - Concluded that neural networks have potential to replace or accelerate finite difference or ray tracing methods to calculate seismic travel times.
- **Using Machine Learning Arrival Picks and High-precision Earthquake Location to Examine the Wasatch Fault Structure**
 - Used NonLinLoc-SSST-coherence to generate multi-scale high precision earthquake locations on a machine learning generated catalog of the 2020 Magna, UT earthquake sequence.
 - Generated first-motion focal mechanisms using waveform similarity.
 - Concluded that the Magna sequence represented heterogeneous rupture, that the Wasatch Fault is lower angle than current seismic hazard models, and that fault segmentation interaction can likely generate seismicity.
- **Ambient Noise Tomography with Beamforming and Joint Monte-Carlo Inversion**
 - Collected and analyzed seismic data from geophone arrays in Frontier Observatory for Research in Geothermal Energy (FORGE) site in southern Utah.
 - Utilized cross-correlation analysis and beamforming with non-linear, tomographic inversion method to analyze the subsurface structure of the area. Utilized blend of nodal and permanent broadband station data.
 - Performed joint Monte-Carlo inversion of two measurement types and interpreted with regional geology.

Sandia National Laboratories, Albuquerque, NM, 2020 – 2023

Graduate Geophysics Intern

- **Hamiltonian Monte-Carlo Inversion for Uncertainty Estimation of Seismic Sources**
 - Explored linear inversion and Hamiltonian Monte-Carlo inversion for time-dependent seismic source estimation.
 - Efficiently estimated uncertainty on high dimensional parameter space with statistics and variational inference
 - Applied to synthetic and real datasets of explosions followed by a cavern collapse.
- **Gradiometry and Wavelet Analysis of Seismic Data of Explosions**
 - Performed wavelet-based, time-frequency analysis of seismic gradiometric data.
 - Analyzed azimuthal dependence of seismic wave propagation for an isotropic seismic source.
 - Examined path dependent scattering for isotropic sources of various depths and yields.

University of Utah, Salt Lake City, UT – Duty Seismologist

2020 - 2023

- Responded to seismic event triggers in real time, including earthquakes, explosions, collapses, teleseismic earthquakes, and false detections.
- Computed preliminary location and magnitude of events as needed and applicable.
- Issued press releases and notified the general public of noteworthy events as applicable.

GeoTest Services, Inc., Bellingham, WA, 2016 – 2018

Geologist/Field and Lab Technician

- Performed materials testing on asphalt, soils, and concrete per American Society for Testing and Materials (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) standards.
- Performed a wide variety of laboratory materials tests, including but not limited to maximum density and optimum moisture tests, compressive and shear strength tests, permeability and consolidation tests, and atterberg liquid and plastic limit.
- Analyzed geophysical data in a professional setting and created professional reports.
- Possessed a variety of professional certifications associated with above listed duties and procedures.

PUBLICATIONS

Peer Reviewed:

- **Wells, D.**, Quach, A., Rajapakshe, O., & Saha, D. (2025). A Comparative Analysis of Feature Extraction and Distance Loss Functions for Unknown Waveform Detection in the Time-Frequency Domain. *IEEE Transaction on Signal Processing*. (In preparation)
- Wei, X., Saha, D., **Wells, D.**, & Quach, A. (2025). Contrasting Time-Frequency Representations for Unknown Waveform Detection. *Institute of Electrical and Electronics Engineers - 2025 IEEE International Conferences on Communications*, 2025.
- **Wells, D. E.**, Bartley, J. Pankow, K.L., & Baker, B. (2025). Evidence for interaction of Wasatch Fault segments at depth. *Seismica*. (In preparation)
- **Wells, D. E.**, Lomax, A., Baker, B., Niemz, P., Pankow, K.L., & Bartley, J. (2024) Wasatch Fault Structure from Machine Learning Arrival Times and High-Precision Earthquake Locations. *Bulletin of the Seismological Society of America*. 4(2024). <https://doi.org/10.1785/0120230247>
- **Wells, D.**, Lin, F. C., Pankow, K., Baker, B., & Bartley, J. (2022). Combining dense seismic arrays and broadband data to image the subsurface velocity structure in geothermally active South-central Utah. *Journal of Geophysical Research: Solid Earth*, 127(7), e2022JB024070.
- Pankow, K. L., Rusho, J., Pechmann, J. C., Hale, J. M., Whidden, K., Sumsion, R., Holt, J., Mesimeri, M., **Wells, D.**, & Koper, K. D. (2020). Responding to the 2020 Magna, Utah, earthquake sequence during the COVID-19 pandemic shutdown. *Seismological Research Letters*. 92(1). 6–16. <https://doi.org/10.1785/0220200265>

Technical Reports:

- Quach, A., **Wells, D.**, & Saha, D. (2025). Detecting Unclassified Electromagnetic Signals for Secure Wireless Communication Using Open Set Recognition . INL LDRD Conclusion Report.
- Wallis, D., Denoso, J., **Wells, D.**, & Krome, C. (2025). Wireless Radio Frequency Signal Identification and Protocol Reverse Engineering Commercialization Effort. INL CRADA Conclusion Report.
- **Wells, D. E.** Poppeliers, C., & Abbott, R. (2025). Using gradiometry and continuous wavelet transform to analyze the displacement and rotational seismic motions produced as part of the source physics experiment – dry alluvium geology. Sandia National Laboratories - SAND Report. SAND2024-XXXX (In Review)
- **Wells, D. E.**, Leiph, P., & Poppeliers, C. (2025). Using Hamiltonian Monte Carlo to estimate time-dependent moment tensors and their uncertainty. Sandia National Laboratories - SAND Report. SAND2024-XXXX (In Review).
- **Wells, D. E.**, Baker, B., & Pankow, K.L. (2023). The feasibility of incorporating a 3D velocity model into earthquake locations around Salt Lake City, UT using a physics informed neural network. Sandia National Laboratories - SAND Report. SAND2023-07417.

Abstracts/Presentations:

- **Wells, D.E.** (2025). Machine Learning for Signal Processing. INL University Days. Presentation.
- Quach, A. & **Wells, D.** (2025). DUNES: Detecting Unclassified Electromagnetic Signals for Secure Wireless Communication Using Open Set Recognition. INL 2025 LDRD Poster Session.
- Sarker, S., Quach, A., & **Wells, D.** (2025). Enhancing Unknown Waveform Detection by Learning Intra-and Inter domain Dependencies with Advanced Attention Fusion Mechanisms. INL Intern Poster Session, 2025.
- **Wells, D.E.**, Krome, C., Laney, J.C., Muqtadir, A., Olvera, H., & Wallis, D. (2025). A Machine Learning Pipeline for Portable Wireless Signal Detection, Classification, and Analysis. Digital Innovation Center of Excellence, Idaho National Laboratory. May Meeting. Poster/Presentation.
- **Wells, D.E.**, Yeck, W., Cole, H., Patton, J., Shelly, D., & Earle, Paul. (2024) Towards Deep Learning Picking at the USGS National Earthquake Information Center. Seismological Society of America. April Meeting. Presentation.

- **Wells, D. E.**, Lomax, A., Baker, B., Niemz, P., Pankow, K.L., & Bartley, J. (2023). Using NonLinLoc-SSST-Coherence and a Machine Learning Earthquake Catalog to Image Fault Structure. Seismological Society of America. April Meeting. Poster.
- **Wells, D. E.**, Lomax, A., Baker, B., & Pankow, K.L. (2022). Relocating the Utah Magna Sequence Using NonLinLoc-SSST-Coherence and 1D and 3D Velocity Models to Constrain the Wasatch Fault System. Latin American and Caribbean Seismological Commission. October Meeting. Poster.
- **Wells, D. E.**, Baker, B., & Pankow, K.L. (2022). Aftershock Relocations Using Nonlinear Inversion, 1D and 3D Velocity Models and Machine Learning to Image Fault Structure. Seismological Society of America. April Meeting. Poster.
- **Wells, D. E.**, Lin, F. C., Pankow, K.L., Baker, B., & Bartley, J. (2021). Combining independent nodal datasets to image the velocity structure beneath the known geothermal resource areas in south-central Utah. Geodetic/Seismological Facility for the Advancement of Geoscience (GAGE/SAGE). August Meeting. Poster/Presentation.
- **Wells, D. E.**, Baker, B., & Pankow, K.L. (2019). Ambient Noise Tomography in Southern Utah Combining Multiple Geophone Deployments and Broadband Data. American Geophysical Union. December Meeting. Poster.

HONORS AND AWARDS

- 2022 Graduate Student Travel Assistance Award Recipient
- 2018 Cooper Hansen Foundation Fellowship Recipient
- National Merit Scholarship Recipient
- Western Undergraduate Exchange Scholarship Recipient
- Distinguished Student Award
- President's List Awardee

GRANTS & FUNDING AWARDS

- 2025 - (PI) National Nuclear Security Administration (NA-241): "Determining Seismic Sensor Infrastructure at the Waste Isolation Pilot Plant (WIPP)." Award Amount: \$130,000.
- 2024 - INL Lab Directed Research and Development (LDRD). "Geometallurgy of Rare Earth Elements for Novel Refinement (GREENR)". Award amount: \$688,000.
- 2023 - Mendenhall Postdoctoral Research Award. "Machine Learning for Global Seismology". Award amount: \$300,000 (approx).

PATENTS

- Patent: US202250192904A1 "Spectrum monitoring and analysis, and related methods, systems and devices". WiFIRE project.
- Patent: US11251889B2 - "Wireless signal monitoring and analysis, and related methods, systems and devices". WiFIRE project.
- Patent: US12418349B2 - Spectrum monitoring and analysis, and related methods, systems and devices". WiFIRE project.

SOFTWARE RELEASES

- **WiFIRE AI/ML Application for Combat Bound Platform** - Comprised of machine learning models trained on wireless signal data, embedded code for the RedWire Carbon software defined radio, GNU radio blocks to host signal detection, classification, anomaly detection, and direction finding capabilities on the GNU radio framework.
- **Detecting Unclassified Electromagnetic Signals for Secure Wireless Communication Using Open Set Recognition** - Using a ML pipeline for classifying unknown wireless signals, addressing the 'open-set recognition' (OSR) problem. Utilizes I/Q data multi-domain feature representation.
- **Open Set Recognition and Characterization of Wireless Signals Using Conditional Diffusion Models** - Function: Ingests IQ data and performs detection and characterization of wireless signals using a conditional diffusion model.

ADDITIONAL SKILLS

Programs and Programming Languages

- Python (3.xx) and packages: Numpy, Scipy, Obspy, Pandas, Cartopy, SciKitLearn, TensorFlow, Keras, PyTorch, Tensorflow, Matplotlib, etc.
- Matlab, FORTRAN, C, C++, csh, bash, Seismic Analysis Code (SAC), SLURM, interactive high-performance computing (HPC), GPU acceleration, parallelization.
- ArcGIS and QGIS, and managing geographic data files in Python.

Communication Languages

- Spanish - Undergraduate Minor, 3 years of study. Semi-fluent in written and spoken context.

PROFESSIONAL REFERENCES

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