

ISSUE

08

FALL 2026

# BIANNUAL NEWSLETTER



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## Overview

### Welcome to Fall 2026

We're pleased to share the latest news and developments from our consortium. This issue brings together recent research highlights, publications, and consortium updates in one place.

Turn to page 3 for a closer look at our *featured research projects* that showcase our team's dedication to addressing some of the most challenging problems in geophysics. On page 5, explore *recent publications* by our members, highlighting our continued impact on scientific progress. Visit page 7 for our *consortium news roundup*, featuring key developments across the consortium. Finally, turn to page 10 to discover our *new members* and welcome the colleagues who have recently joined our team.

We hope you enjoy this issue and feel connected to the momentum of our work. Happy reading!

Find more about our consortium by either contacting us via e-mail [[deepwave@kaust.edu.sa](mailto:deepwave@kaust.edu.sa)] or by visiting the DeepWave website [[deepwave.kaust.edu.sa](http://deepwave.kaust.edu.sa)].

DeepWave is an industry funded research consortium at King Abdullah University of Science and Technology (KAUST), which focuses on the application of machine (deep) learning numerical algorithms to wave-equation-based processing, imaging, and inversion.

The application of these techniques extends to objectives ranging from global Earth discovery, to natural resources exploration, to subsurface monitoring as well as non-destructive testing and medical imaging.

### Goal

To be a leading center for the research and development of machine learning algorithms on waveform data with applications ranging from the exploration and discovery of the Earth to reservoir characterization and monitoring for oil and gas, geothermal, and CO<sub>2</sub> storage purposes.

### Mission

To foster an environment of effective research for the students and researchers that promotes seamless interaction with our sponsors.

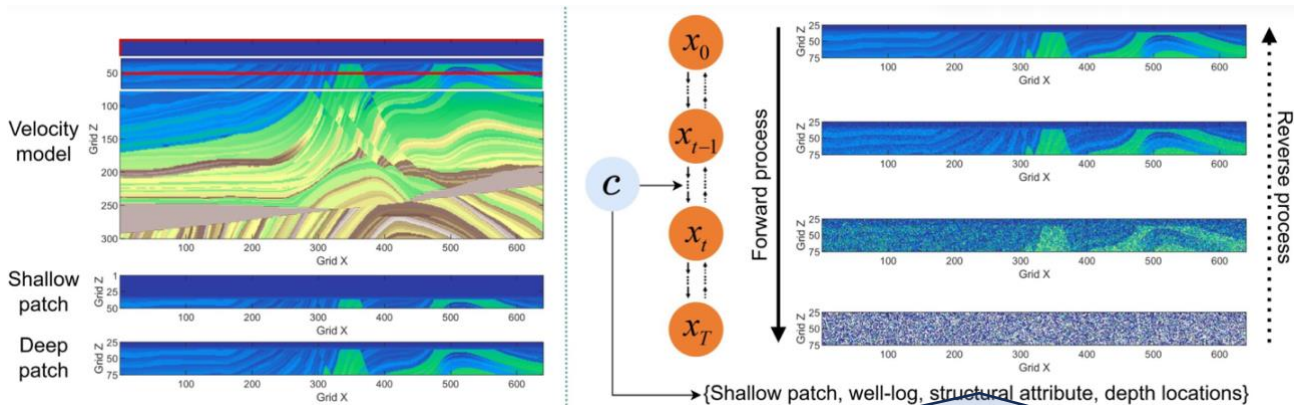
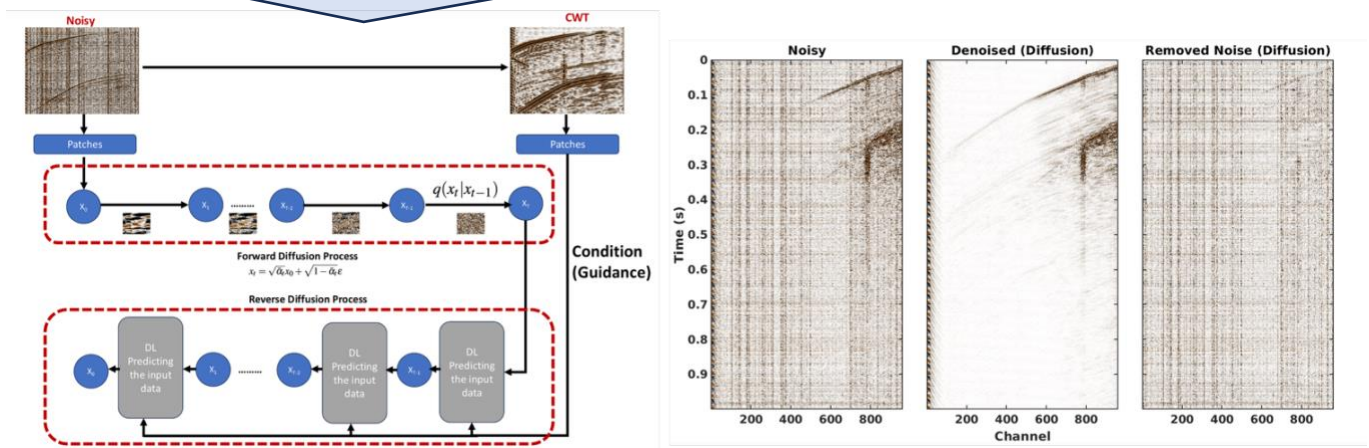
# Samples of DeepWave Research

## Distributed Acoustic Sensing Denoising Using a Self-supervised Conditional Diffusion Model

[Omar M. Saad](#), and [Tariq Alkhalifah](#)

Code: [https://github.com/DeepWave-KAUST/DiffusionDAS\\_Denoising-pub](https://github.com/DeepWave-KAUST/DiffusionDAS_Denoising-pub)

A self-supervised conditional diffusion framework is developed to enhance distributed acoustic sensing (DAS) data quality without requiring clean training labels. Unlike conventional diffusion models that predict Gaussian noise, the proposed approach directly predicts the input data using a customized neural network guided by the continuous wavelet transform (CWT). The coarsest CWT scale provides structural information to suppress complex noise while preserving coherent seismic signals. The framework also enables single-step inference, reducing computational costs. Evaluations on synthetic and field DAS datasets from FORGE, SAFOD, and southwest Greece demonstrate improved noise attenuation, enhanced signal continuity, and minimal signal leakage compared with benchmark methods. These results highlight its potential for recovering weak earthquake and microseismic signals in challenging low signal-to-noise environments.



## Shallow-to-Deep Velocity Model Building via Diffusion Models

[Shijun Cheng](#), [Randy Harsuko](#), and [Tariq Alkhalifah](#)

Code: <https://github.com/DeepWave-KAUST/DiffVMB-pub>

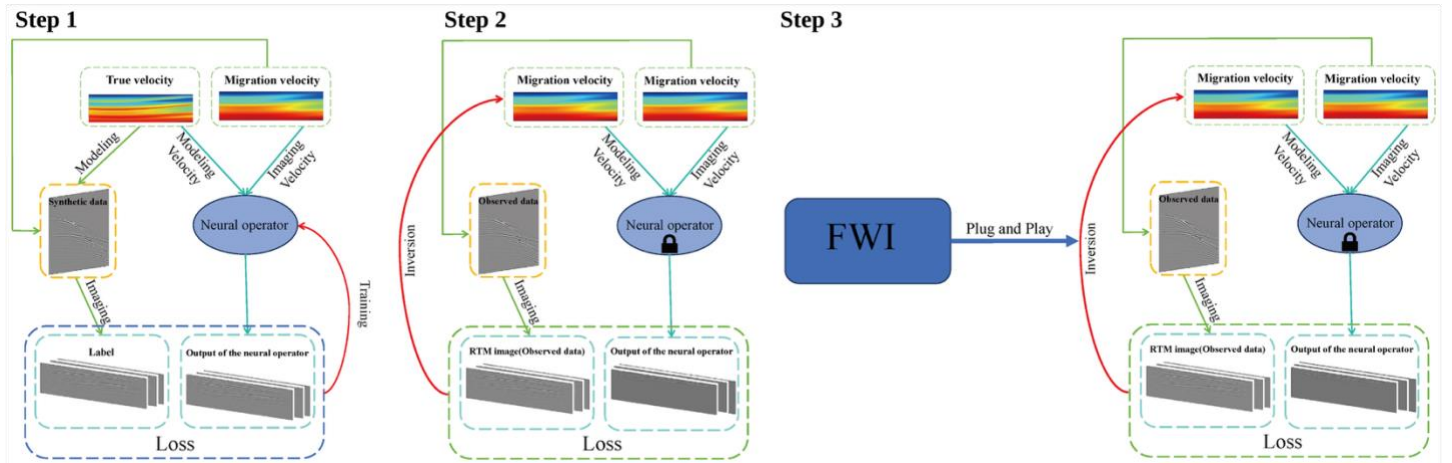
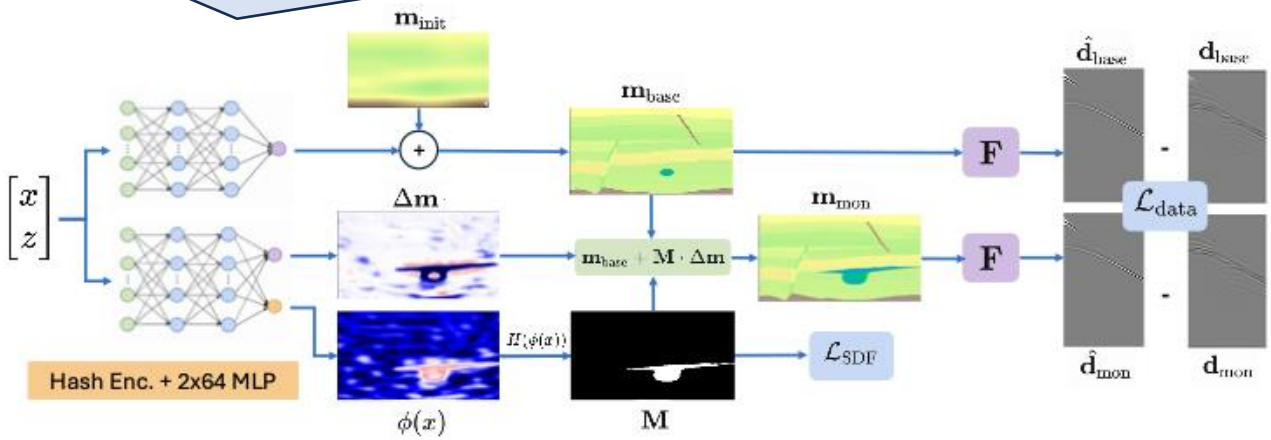
Seismic data are recorded at the surface, so velocity information naturally flows from shallow to deep, as in layer stripping. We use this flow in a generative diffusion framework that builds 2D velocity models incrementally, generating each deeper section conditioned on the shallower velocity and its depth encoding. The generation can be guided by structural constraints, sparse well logs, migration images, and smooth background velocities. On both the Marmousi model and offshore Australia field data, the generated velocity models are good and help reduce cycle skipping as FWI initial models, while ensemble sampling offers a measure of uncertainty.

# Samples of DeepWave Research

## Implicit Time-lapse FWI with Level Set Functions

[Muhammad Iqbal Khatami](#), [Wolfgang Heidrich](#), and [Tariq Alkhalifah](#)

Time-lapse FWI is a powerful tool for monitoring subsurface property changes. However, conventional time-lapse FWI is often contaminated by artifacts caused by non-repeatable noise that are unrelated to actual reservoir changes. We propose a novel time-lapse FWI framework that simultaneously inverts for the baseline model, time-lapse changes, and their geometric shape, represented by a level set function. The level set function constrains the inverted time-lapse changes to the region of interest, effectively suppressing artifacts unrelated to the change in the reservoir. We parameterize the subsurface models using two implicit neural representations (INRs), which are jointly optimized during FWI process. Synthetic experiments and field applications to the Volve and Sleipner field demonstrate that our method robust to noise and produces clearer time-lapse change, while suppressing the artifacts unrelated to actual reservoir changes.



## Accelerating FWI Using a Neural Operator-Based Inversion Framework

[Xiao Ma](#), [Tariq Alkhalifah](#)

Full waveform inversion (FWI) is costly and prone to local minima. We train a **neural operator** as a surrogate for modeling and time-lag RTM, then invert its image misfit by automatic differentiation to inject high-frequency RTM detail into the migration velocity. With FWI as a plug-and-play term, it gives higher-resolution models in 10–15 iterations on out-of-distribution Overthrust and offshore-Australia field data.

# Samples of DeepWave Research

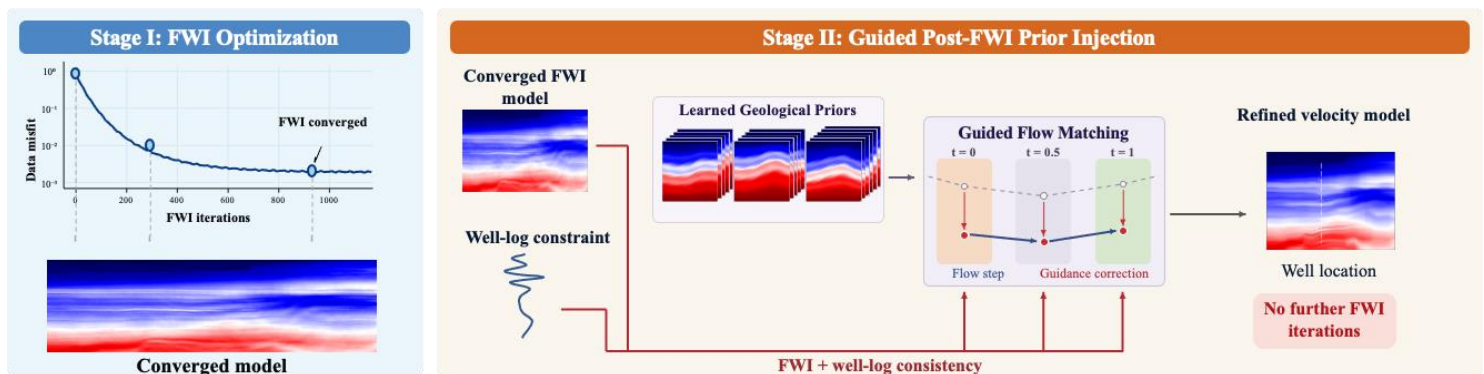
## Post-FWI Injection of Learned Priors Using a Flow Matching Model

Hao Zhang, and Tariq Alkhalifah

Code: <https://github.com/DeepWave-KAUST/PostFWI-pub>

You receive a velocity model from a vendor—but not the seismic data behind it. How can you regularize the model, improve its geological detail, or incorporate newly available well logs? Revisiting the inversion can be expensive, and without the original data, it may not be possible. **PIP makes post-FWI refinement possible.** Using guided Flow Matching, PIP brings learned geological priors and optional well-log constraints into an existing velocity model, without requiring the original seismic data or additional FWI iterations. Beyond improving geological detail, well guidance can shift model features in depth to help correct depth misties. Your existing model becomes the starting point for a more geologically informed, well-consistent result.

### Post-FWI Injection of Priors (PIP)



## Recent Publications

**Abedi M.M.; Pardo D.; Alkhalifah T.**, “A Green-Integral-Constrained Neural Solver With Stochastic Physics-Informed Regularization”, 2026, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2026.3720567.

**Cheng S.; Taufik M.H.; Alkhalifah T.**, “Seismic wavefield solutions via physics-guided generative neural operator”, 2026, Geophysics, 10.1190/GEO-2026-1784.

**He L.; Song C.; Alkhalifah T.; Chen T.; Liu T.; Liu C.**, “M-SSIM-3DIFWI: 3-D Implicit Full Waveform Inversion Based on the Multiscale Structural Similarity”, 2026, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2026.3704938.

**Ma X.; Taufik M.H.; Alkhalifah T.**, “Diffusion Priors Enhanced Velocity Model Building From Time-Lag Images Using a Neural Operator”, 2026, Journal of Geophysical Research: Machine Learning and Computation, 10.1029/2025JH001223.

**Mu X.; Saad O.M.; Wang S.; Alkhalifah T.**, “Quasi-Global Search Behaviour of Large-Step Gradient-Based Optimization in Full Waveform Inversion”, 2026, Geophysical Prospecting, 10.1111/1365-2478.70265.

## Recent Publications (cont'd)

**Saad O.M.; Alkhalifah T.**, “*SiameseFit: Latent Seismic Data Comparison for Enhanced Full Waveform Inversion and Cycle-Skipping Mitigation*”, 2026, Geophysical Prospecting, 10.1111/1365-2478.70203.

**Saad O.M.; Chen Y.; Alkhalifah T.**, “*U-Trans: a foundation model for seismic waveform representation and enhanced downstream earthquake tasks*”, 2026, Scientific reports, 10.1038/s41598-026-41454-x.

**Song C.; Alkhalifah T.; Bin Waheed U.; Wang S.; Liu C.**, “*Physics-Constrained Deep-Learning-Based Full-Waveform Inversion: A Practical Source-Independent Strategy with Two Real Data Applications*”, 2026, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2026.3658747.

**Wang N.; Ravasi M.; Deheuvels M.; Alkhalifah T.**, “*Application of multidimensional deconvolution to enhance seismic-while-drilling data imaging*”, 2026, Geophysics, 10.1190/geo-2025-0332.

**Wang N.; Alkhalifah T.**, “*Plug-And-Play Regularized Multidimensional Deconvolution for Accurate Wavefield Retrieval and Imaging*”, 2026, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2026.3708162.

**Wang S.; Alkhalifah T.**, “*Implicit full waveform inversion imaging*”, 2026, Geophysical Journal International, 10.1093/gji/ggag277.

**Yang Y.; Saad O.M.; Alkhalifah T.**, “*Real-Time Microseismic Event Location With Latent Diffusion Models*”, 2026, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2026.3718892.

**Cheng S.; Zhang H.; Alkhalifah T.**, “*Self-Supervised Seismic Resolution Enhancement*”, 2025, IEEE Transactions on Geoscience and Remote Sensing, 10.1109/TGRS.2025.3528414.

**Harsuko R.; Cheng S.; Alkhalifah T.**, “*Propagating the Prior From Shallow to Deep With a Pre-Trained Velocity-Model Generative Transformer Network*”, 2025, Journal of Geophysical Research: Machine Learning and Computation, 10.1029/2024JH000408.

**Huang X.; Wang F.; Alkhalifah T.**, “*Diffusion-Based Subsurface CO<sub>2</sub> Multiphysics Monitoring and Forecasting*”, 2025, Journal of Geophysical Research: Machine Learning and Computation, 10.1029/2025JH000603.

**Mu X.; Alkhalifah T.; Huang J.**, “*Attenuation-compensated viscoelastic reverse time migration with finite-difference operators*”, 2025, Geophysics, 10.1190/geo2024-0295.1.

**Saad O.M.; Alkhalifah T.**, “*F-SiameseFWI: A novel deep-learning framework for multisource full-waveform inversion*”, 2025, Geophysics, 10.1190/GEO2024-0785.1.

**Wang N.; Ravasi M.; Alkhalifah T.**, “*Accelerating Marchenko Imaging by Self-Supervised Prediction of Focusing Functions*”, 2025, Journal of Geophysical Research: Machine Learning and Computation, 10.1029/2025JH000673.

## News

### Annual Meeting 2026

The Consortium's 2026 Annual Meeting took place on **13 - 14 August 2026 in Houston, US**. Over two days, participants explored advances in machine learning for seismic processing, imaging, and inversion across seven sessions covering scientific machine learning, diffusion models, full waveform inversion, time-lapse imaging, and AI-driven geophysics. Technical presentations, invited talks, and interactive discussions fostered scientific exchange, while the event concluded with business meeting with updates and feedback to help shape the consortium's research priorities and ongoing activities. This year's meeting was hosted by Chevron at The ION and we are grateful to them.



### IMAGE 2026 Booth

At IMAGE 2026 in Houston, DeepWave participated in the **technical exhibition** with a dedicated **booth**, providing an opportunity to meet industry representatives, strengthen professional connections, and exchange perspectives on emerging challenges in geophysical research. The event also served as a platform to introduce the Consortium's collaborative research activities and highlight its ongoing efforts to advance machine learning methods for seismic applications. For a comprehensive list of all our presentations, [click here](#).



**OMAR  
SAAD**

WINNER OF THE EAGE  
ARIE VAN WEELDEN  
AWARD 2026

FOR SIGNIFICANT CONTRIBUTIONS  
BY A YOUNG PROFESSIONAL



### EAGE 2026 Award

**Omar Saad**, the recipient of the **2026 Arie van Weelden Award**, is an internationally recognized leader whose pioneering research has transformed geophysics, particularly through advances in full waveform inversion (FWI), seismic denoising, and the integration of artificial intelligence into geoscientific analysis. The award recognizes his outstanding contributions to the field.

### 2025-2026 PSE Dean's Award

PhD students Ning Wang and Francesco Brandolin have received the **2025 - 2026 Physical Science and Engineering (PSE) Dean's Award** in recognition of their outstanding academic performance. Their achievements place them among the top 10% of students in the PSE Division, reflecting their intellectual rigor, and commitment to academic excellence.

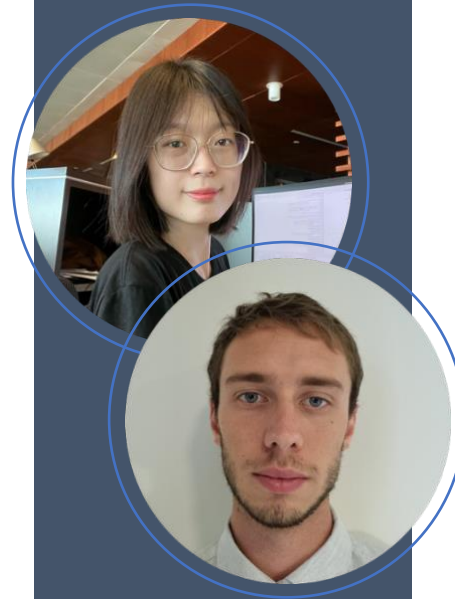


### IMAGE 2025 Best Student Poster Award

**Yuanyuan Yang**, a PhD student, received the Best Student Poster Award in the Induced and Passive Seismic (IPS) sessions at the IMAGE 2025 Conference for the paper *"Real-Time Microseismic Event Location Using a Latent Diffusion Model."* The award recognizes the quality and significance of this research, which explores the **application of generative models to real-time microseismic monitoring**. The work benefited from collaborations and scientific discussions within the DeepWave Consortium.

### Celebrating Our Recent Alumni Graduate

**Yuanyuan Yang** graduated in June 2026 and will be continuing her research path as a Postdoctoral Scholar jointly at the **University of California, Berkeley** and **Lawrence Berkeley National Laboratory**. Her research focuses on machine learning-enhanced subsurface monitoring using passive seismic data (including earthquakes and microseismic events) with applications to geothermal reservoirs. We wish her a bright and successful future ahead!



## News (cont'd)

### DeepWave on Github

Thanks to the contributions of our team our [Github organization](#) is now proudly hosting *86 stable repositories* and *49 in development*. These private repositories are designed to facilitate seamless code sharing between DeepWave researchers and Consortium sponsors. A total of *50 public repos* which are linked to published research have also become available to the whole community after completing a privacy period of 6 months.

### 2026 Annual Report

Our most recent Annual Report comprised of **38 papers** one for each of the latest completed projects by members of the KAUST team. We are proud to have reached this number following an upward trend compared to 35 in 2025, 25 in 2024 and 17 in 2023.

## Announcement

### Student and Postdoc opening at DeepWave (KAUST)

[Join our research group](#) as a fully-funded KAUST **PhD candidate** and get the chance to work alongside a group of motivated individuals who explore cutting-edge techniques in machine learning, data-driven modeling, and computational geophysics while tackling real-world challenges!

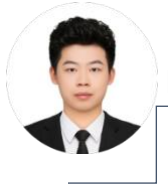
Do you have a PhD in a relevant field and strong skills in Python and PyTorch? Join our team as a **Postdoctoral Fellow** and work on tackling complex geophysical challenges. We're looking for researchers eager to push the boundaries of AI-driven geophysics. Get in touch by sending your application to [deepwave@kaust.edu.sa](mailto:deepwave@kaust.edu.sa)



**Miraz Badrais** | *PhD Student*

Miraz received her Bachelor's degree in **Computer Science** with a minor in **Artificial Intelligence** from King Abdulaziz University and her Master's degree in **Applied Computational Science and Engineering** from Imperial College London. Her Master's research at the German Aerospace Center (DLR) focused on implementing Adapt-then-Combine Full Waveform Inversion (ATC-FWI) for autonomous robotic subsurface exploration utilising GPU computing.

Her research interests lie at the intersection of full waveform inversion (FWI), high-performance computing (HPC), and numerical optimisation, with a current focus on GPU acceleration and decentralised seismic inversion.



**Luotao Zhang** | *PhD Student*

Luotao received his Bachelor's degree in **Intelligence Science and Technology** and his Master's degree in **Electronic Information** from Shandong University of Science and Technology, China. During his Master's studies, his research focused on implicit neural representations (INRs) for geophysical problems, including improving the frequency response of implicit full waveform inversion with Fourier encoding and the continuous reconstruction of seafloor topography from multibeam sonar data.

His research interests include full waveform inversion, INRs, and deep learning for geophysical inverse problems. Currently, he is developing INR-based 3D interpolation methods for seismic data.



**Ting Yang** | *MSc Student*

Ting Yang received her Bachelor's degree in Geophysics from Jilin University, China. She joined KAUST in 2025 to pursue a Master's degree in Geophysics.

Her research interests lie at the intersection of seismology and machine learning, with a particular focus on applying deep learning methods to seismic data analysis and subsurface characterization.

## New Members

Our team is growing. Learn more about our new additions here.



### Jorge Vázquez | MSc Student

Jorge received his Bachelor's degree in **Geophysical Engineering** from the Universidad Nacional Autónoma de México (UNAM). His undergraduate research focused on the inversion of gravity and magnetic data, while his thesis explored the use of deep learning for the prediction and reconstruction of geophysical well logs.

His current research focuses on seismic super-resolution and full-waveform inversion (FWI), with particular emphasis on the integration of deep generative models to improve seismic imaging, reconstruction, and subsurface characterization.

## New Members

Our team is growing. Learn more about our new additions here.

We thank our **Industry Sponsors** for their support

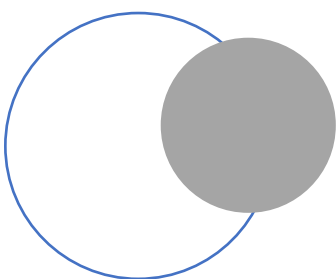


## Scope of research

The Consortium aims to deliver the most effective solutions to waveform processing, imaging, and inversion challenges across multiple scales.



DeepWave Consortium | Issue 08 | Fall 2026



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