

DR. DEEPAK KUMAR (PH.D)

COMPUTATIONAL GEOPHYSICIST | SEISMIC INVERSION | AI/ML SPECIALIST

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PROFESSIONAL PROFILE

Computational geophysicist with more than eight years of international research and industry experience across Poland, India, and the UAE. Develops physics-based and machine-learning workflows for seismic inversion, uncertainty calibration, velocity-model building, and crustal imaging. Experienced with wide-angle and 3-C data, active and passive seismic datasets, team leadership, and scientific computing in Python and MATLAB.

CORE EXPERTISE

Inversion and imaging: Full-waveform inversion, acoustic-impedance inversion, tomography, ray tracing, velocity modeling, depth imaging, and seismic-to-well ties.

Scientific machine learning: Physics-informed deep learning, residual learning, ensemble uncertainty, conformal calibration, sparse regularization, CNNs, SVMs, and supervised/unsupervised learning.

Seismic and Earth science: Wide-angle and 3-C acquisition, 2D/3D processing and interpretation, crust–mantle structure, anisotropy, discontinuities, gravity, and heat-flow modeling.

SELECTED RESEARCH IMPACT

- Developed a geometry-invariant, physics-encoded residual FWI ensemble. Across 1,000 synthetic models and six acquisition families, it reduced error by 38% relative to the classical prior; zero-shot Marmousi-2 testing reduced error from 354 to 304 m/s.
- Built a calibration and block-bootstrap workflow for a 210-km wide-angle profile using 2,000 primary first arrivals and 9,919 reflections, separating sampling uncertainty from velocity/model-class uncertainty in Moho estimates.
- Developed ADMM-guided physics-informed learning for 2D acoustic-impedance inversion with reweighted ℓ_1 sparse regularization.

PROFESSIONAL EXPERIENCE

Assistant Professor – Seismic Research (Lithospheric Team)

Institute of Geophysics, Polish Academy of Sciences (IGF PAN)

Present

Warsaw, Poland

- Lead research on lithospheric-scale seismic imaging, crust–mantle structure, inversion, and modeling of active and passive seismic datasets.
- Develop 2D/3D inversion and geodynamic models; investigate crustal anisotropy and seismic discontinuities.
- Collaborate on EU-funded research projects and contribute to student supervision, graduate teaching, and mentoring.

Research Assistant – Lithospheric Research

Institute of Geophysics, Polish Academy of Sciences (IGF PAN)

Aug 2025 – Jan 2026

Warsaw, Poland

- Conducted phase picking, inversion, and seismic imaging for lithospheric studies on Spitsbergen.
- Modeled active and passive seismic datasets for the crust and upper mantle and contributed to velocity-model and anisotropy analysis.

Consultant / Geoscientist – Oil and Gas

Planetone-Group

Jun 2025 – Jul 2025

Dubai, UAE

- Led seismic interpretation for a 3D block, including data loading and horizon and fault picking.
- Used DecisionSpace Geosciences (Landmark) in integrated interpretation and velocity-modeling workflows and coordinated with Halliburton teams.

Research Geoscientist & Team Lead – Seismic Core

IndiCOMET Geoscience

May 2024 – Mar 2025

Noida, India

- Led the Seismic Inversion and Modeling Team and designed workflows for velocity-model building and depth imaging in complex geological settings.
- Implemented tomographic inversion and deep-learning inversion with ℓ_1 sparse regularization for subsurface characterization.
- Integrated processing, interpretation, and modeling with FOCUS/ECHOES and Petrel; prepared technical documentation and presented results to stakeholders.

PROFESSIONAL EXPERIENCE (CONTINUED)

Senior Project Associate – Shallow Seismic

Jul 2023 – Apr 2024

CSIR–National Geophysical Research Institute (CSIR-NGRI)

Hyderabad, India

- Applied machine learning and deep learning to seismic workflows for underground carbon-capture and storage risk assessment and post-stack seismic inversion.
- Performed denoising, deconvolution, velocity analysis, seismic-to-well ties, and reservoir interpretation using Petrel.

Senior Project Associate – Deep Seismic Division

Jul 2022 – Nov 2022

CSIR–National Geophysical Research Institute (CSIR-NGRI)

Hyderabad, India

- Processed and interpreted 3D seismic data for the Upper Assam Basin, including seismic-to-well ties and hydrocarbon-trap evaluation.
- Applied AI/ML and computer-vision methods to refine subsurface geological models.

DST-INSPIRE Fellow / Research Scholar – Deep Seismic Division

Jan 2016 – Jan 2021

CSIR–National Geophysical Research Institute (CSIR-NGRI)

Hyderabad, India

- Analyzed wide-angle 3-C seismic data from the Dharwar Craton and constructed P- and S-wave velocity, composition, and anisotropy models.
- Used ProMAX processing and ray-trace inversion for V_p , V_s , V_p/V_s , Poisson's ratio, faults, shear zones, and crustal boundaries.
- Investigated the Hales Discontinuity and upper-mantle low-velocity zones and translated the work into peer-reviewed publications and current manuscripts.

SELECTED PUBLICATIONS AND PREPRINTS

- **Kumar, D.**, Tripathi, J. N., and Behera, L. (2026). "Reliability-calibrated deep residual full-waveform inversion using geometry-invariant physics encoding: synthetic validation and zero-shot Marmousi-2 testing." arXiv:2607.28535. *Submitted to Computers & Geosciences*. DOI: 10.48550/arXiv.2607.28535.
- **Kumar, D.**, Behera, L., and Czuba, W. (2026). "Calibrated uncertainty for wide-angle crustal models: how firmly is the Dharwar Craton Moho actually constrained?" arXiv:2607.28199. *Submitted to Geophysical Journal International*. DOI: 10.48550/arXiv.2607.28199.
- **Kumar, D.** and Tripathi, J. N. (2026). "ADMM-Guided Physics-Informed Deep Learning for Two-Dimensional Acoustic Impedance Inversion with Reweighted ℓ_1 Sparse Regularization." EarthArXiv preprint. *Submitted to IEEE Transactions on Geoscience and Remote Sensing*. DOI: 10.31223/X56J49.
- **Kumar, D.** and Behera, L. (2025). "Evidence of Hales Discontinuity from Seismic Anisotropic Studies beneath Dharwar Craton of Southern India by Using 3-C Wide-angle Seismic Data." *Under review at Gondwana Research*.
- Behera, L. and **Kumar, D.** (2022). "Deep Crustal Structure and Compositions for Tectonic and Geodynamic Implications of the Dharwar Craton (Southern India) Inferred from 3-C Wide-angle Seismic Data." *Journal of Asian Earth Sciences*, 105092.
- **Kumar, D.** and Behera, L. (2023). "Upper-crustal structure, compositions and tectonic settings obtained from Perur–Chikmagalur 3-C seismic profile of Archean Dharwar Province, southern India." *Acta Geophysica*.

EDUCATION

Ph.D. in Geophysics, Osmania University, Hyderabad, India

Thesis: *Imaging of the crust in Dharwar Craton of India using 3-C seismic data*

Post-Graduation Program in Artificial Intelligence and Machine Learning, The University of Texas at Austin, USA

M.Sc. in Marine Geophysics, Andhra University, Vizag, India – Gold Medalist (University Topper)

B.Sc. in Physics (Hons), St. Columba's College, VBU, Hazaribagh, India

TECHNICAL TOOLS

Programming: Python, MATLAB, LaTeX. **ML:** TensorFlow, Keras, CNNs, SVMs, NLP, time-series forecasting, ensemble learning, and conformal uncertainty.

Geophysics: Seismic Unix, FOCUS/ECHOES, ProMAX, Rayinvr, DecisionSpace Geosciences (Landmark), OpendTect, Petrel, seismic tomography, and fast-marching traveltimes.

PROFESSIONAL ENGAGEMENT

Mentored two Ph.D. students at CSIR-NGRI (Jan 2018 – Jan 2022); delivered a virtual seismic-methodology workshop for undergraduate geophysics students in Nigeria (Apr – May 2022); and gave an invited SAGA/WITS University talk on Dharwar Craton crustal structure (Aug 2020).