

DR. DEEPAK KUMAR (PH.D)

ASSISTANT PROFESSOR | COMPUTATIONAL GEOPHYSICIST
SEISMIC INVERSION & UNCERTAINTY QUANTIFICATION

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RESEARCH PROFILE

Computational geophysicist with more than eight years of research and industry experience in active-source seismology, wide-angle seismic imaging, crustal velocity modelling, full-waveform inversion, and uncertainty quantification. Develops physics-informed machine-learning methods that integrate classical inversion with calibrated deep learning. Experienced in 3-C seismic analysis, crust-mantle structure, anisotropy, and reproducible computational workflows across academic and applied geoscience settings in India, the UAE, and Poland.

SELECTED RESEARCH CONTRIBUTIONS

- Developed a geometry-invariant, physics-encoded deep full-waveform inversion framework that uses a calibrated residual ensemble and held-out-shot physics auditing for uncertainty assessment and zero-shot Marmousi-2 evaluation.
- Quantified sampling and model-class uncertainty in Dharwar Craton Moho estimates using complete-shot validation, receiver-coordinate block bootstrap analysis, and velocity-model trade-off experiments.
- Constructed P- and S-wave crustal velocity, composition, and anisotropy models from 3-C wide-angle seismic observations, including interpretation of the Hales discontinuity and upper-mantle low-velocity zones.
- Integrated seismic processing, ray-based and full-waveform inversion, fast-marching methods, and machine learning into reproducible Python-based research workflows.

PUBLICATIONS AND MANUSCRIPTS

Manuscripts submitted or under review

- **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 preprint*, arXiv:2607.28535 [physics.geo-ph]. doi:10.48550/arXiv.2607.28535. Manuscript submitted to *Computers & Geosciences*.
- **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 preprint*, arXiv:2607.28199 [physics.geo-ph]. doi:10.48550/arXiv.2607.28199. Manuscript submitted to *Geophysical Journal International*.
- **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*. doi:10.31223/X56J49. Manuscript submitted to *IEEE Transactions on Geoscience and Remote Sensing*.
- **Kumar, D.** and Behera, L. (2025). Evidence of Hales discontinuity from seismic anisotropic studies beneath Dharwar Craton of southern India using 3-C wide-angle seismic data. Manuscript under review at *Gondwana Research*.

Peer-reviewed journal articles

- **Kumar, D.** and Behera, L. (2023). Inversion of 3-C seismic data to delineate P- and S-wave velocity structure, composition and anisotropy model of the Dharwar Craton, southern India. *Geohorizons*.
- **Kumar, D.** and Behera, L. (2023). Upper-crustal structure, compositions and tectonic settings obtained from the Perur-Chikmagalur 3-C seismic profile of the Archean Dharwar Province, southern India. *Acta Geophysica*.
- 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.

Other publication

- **Kumar, D.**, Jyothula, M., and Betha, V. (2014). Hydrocarbon exploration in Himalayan region—a tough challenge with high reward. *YoungPetro*, 11th issue, Spring 2014. Online article.

ACADEMIC AND RESEARCH APPOINTMENTS

Assistant Professor, Seismic Research (Lithospheric Team)

Present

Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland

- Lead research on lithospheric-scale seismic imaging, crust-mantle structure, seismic discontinuities, and anisotropy using active- and passive-source observations.
- Develop inversion, geodynamic modelling, and computational workflows; collaborate across research projects and contribute to student mentoring.

Research Assistant, Lithospheric Research

Aug 2025 – Jan 2026

Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland

- Conducted phase picking, seismic imaging, and velocity modelling for active and passive seismic studies of Spitsbergen crust and upper mantle.

Consultant / Geoscientist

Jun 2025 – Jul 2025

Planetone Group, Dubai, UAE

- Led 3-D seismic interpretation activities, including data loading and horizon and fault picking, and coordinated integration with Halliburton collaborators.
- Applied DecisionSpace Geosciences workflows to seismic interpretation and velocity modelling.

Research Geoscientist & Team Lead, Seismic Core

May 2024 – Mar 2025

IndiCOMET Geoscience, Noida, India

- Led seismic inversion and modelling workflows for velocity-model building and depth imaging in complex geological settings.
- Implemented tomographic and deep-learning inversion methods, including sparse ℓ_1 optimization; documented and presented results to technical stakeholders.

Senior Project Associate, Shallow Seismic

Jul 2023 – Apr 2024

CSIR-National Geophysical Research Institute, Hyderabad, India

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

Senior Project Associate, Deep Seismic Division

Jul 2022 – Nov 2022

CSIR-National Geophysical Research Institute, Hyderabad, India

- Processed and interpreted 3-D seismic data from the Upper Assam Basin, including seismic-to-well ties and AI/ML-assisted subsurface characterization.

DST-INSPIRE Fellow and Research Scholar

Jan 2016 – Jan 2021

Deep Seismic Division, CSIR-NGRI, Hyderabad, India

- Analysed 3-C wide-angle seismic data from the Dharwar Craton and developed P-wave, S-wave, V_p/V_s , Poisson's-ratio, and anisotropy models using ProMAX and ray-tracing inversion.
- Identified and interpreted crustal faults, shear zones, the Hales discontinuity, and upper-mantle low-velocity zones; communicated results through journal articles and international conferences.

Junior Research Fellow, Seismology Group

Jun 2015 – Aug 2015

Wadia Institute of Himalayan Geology, Dehradun, India

- Analysed regional seismicity and prepared seismicity maps for the north-west Himalaya.

EDUCATION

PhD in Geophysics

Osmania University, Hyderabad, India

Thesis: *Imaging of the crust in Dharwar Craton of India using 3-C seismic data*. Supervisor: Dr Laxmidhar Behera, Chief Scientist, Deep Seismic, CSIR-NGRI. Developed crustal velocity and anisotropy models from wide-angle three-component seismic data.

Post-Graduation Program in Artificial Intelligence and Machine Learning

The University of Texas at Austin, USA

Training in machine learning, deep learning, natural language processing, computer vision, and advanced data analysis. Capstone: end-to-end machine-learning pipeline for locating lung opacity on chest radiographs for pneumonia detection.

MSc in Marine Geophysics

Andhra University, Visakhapatnam, India

Distinction: Gold Medalist and University Topper.

Dissertation in seismic data processing at CSIR-NGRI using FOCUS ECHOES; participated in a marine geophysics expedition aboard ORV *Sagar Kanya* organized by NCAOR.

BSc (Hons) in Physics

St. Columba's College, Vinoba Bhave University, Hazaribagh, India

Foundation in classical mechanics, electromagnetism, quantum physics, thermodynamics, applied mathematics, and computational modelling.

HONOURS AND AWARDS

2019	Young Scientist Award , 2nd Triennial FIGA Congress on “Geosciences for Sustainable Development Goals”
2019	Certificate of Excellence , SEG/Chevron Student Leadership Symposium
2015	DST-INSPIRE Fellowship , Department of Science and Technology, Government of India
2014	Gold Medal , University topper, MSc Marine Geophysics, Andhra University
2014	Prof. Jagdeo Singh and D. S. Balakrishna Memorial Grant , IGU 50th Annual Convention, CSIR-NGRI
2013	Certificate of Sailing aboard ORV <i>Sagar Kanya</i> , National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences, Government of India

SELECTED PROFESSIONAL DEVELOPMENT

Computers, Waves, Simulations: A Practical Introduction to Numerical Methods Using Python, Coursera	Dec 2024
Climate Change: Carbon Capture and Storage, Coursera	Nov 2024
Seismic Processing Velocities - Geophysics, Udemy	Nov 2024
AIML Python Boot Camp, Great Learning	Aug 2022
Petrel Seismic Interpretation, Udemy	Jul 2022
Machine Learning and Its Application in Oil and Gas, Edvantage India Pvt. Ltd.	Nov 2021

SELECTED CONFERENCE PRESENTATIONS

- **Kumar, D.** and Behera, L. (2020). Crustal structure and composition using 3-C wide-angle seismic data along the Perur-Chikmagalur profile of Dharwar Craton, India. IGC, New Delhi.
- **Kumar, D.** and Behera, L. (2019). Upper-crustal structure and composition from P- and S-wave velocity modelling along the Perur-Chikmagalur 3-C seismic profile of Dharwar Craton, India. FIGA, Hyderabad.
- SEG Annual Meeting (2019), San Antonio, Texas, USA.
- **Kumar, D.** and Behera, L. (2017). P- and S-wave velocity modelling and inversion using 3-C seismic data in the Western Dharwar Craton. SPG, Jaipur.

ACADEMIC MENTORING AND INVITED TEACHING

Mentor, CSIR-NGRI

Jan 2018 – Jan 2022

Hyderabad, India

Mentored two PhD students in laboratory research, seismic data processing, interpretation, and modelling.

Workshop Instructor

Apr 2022 – May 2022

Nigeria (virtual)

Delivered a workshop on seismic methodology for undergraduate geophysics students, covering acquisition, processing, inversion, and interpretation.

Invited Speaker, South Africa Geoscience Association

Aug 2020

Virtual talk hosted by the University of the Witwatersrand, South Africa

Presented *Deep crustal structure and composition using 3-C wide-angle seismic data along the Perur-Chikmagalur profile of Dharwar Craton, India.*

SELECTED COMPUTATIONAL PROJECTS AND RESEARCH SOFTWARE

- **Geophysical computing:** Python workflows for seismic inversion, velocity modelling, fast-marching traveltime calculations, uncertainty calibration, and reproducible experiment management.
- **Predictive modelling:** Time-series forecasting workflows using ARIMA, LSTM, and GRU architectures, with data preparation and model evaluation.
- **Computer vision:** CNN image-classification and transfer-learning workflows; capstone pipeline for locating lung opacity on chest radiographs.
- **NLP and unsupervised learning:** Text classification, sentiment analysis, keyword extraction, transformer methods, clustering, anomaly detection, PCA, and t-SNE.
- **Portfolio links:** Great Learning e-portfolio | GitHub.

TECHNICAL SKILLS

Seismic and geoscience	Seismic Unix, FOCUS ECHOES, ProMAX, rayinvr, DecisionSpace Geosciences, OpendTect, Petrel, ArcGIS, CorelDRAW
Programming and ML	Python, MATLAB, LaTeX, TensorFlow, Keras, CNNs, SVMs, supervised and unsupervised learning, time-series forecasting
Methods	2-D/3-D/3-C and wide-angle seismic processing and interpretation, ray-based and full-waveform inversion, velocity modelling, gravity and heat-flow modelling
Languages	English (fluent), Hindi (native), Polish (beginner)

RESEARCH FOCUS

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| <ul style="list-style-type: none">• Lithospheric-scale seismic imaging• Wide-angle and 3-C seismology• Crust-mantle structure and discontinuities• Seismic anisotropy and tectonic evolution | <ul style="list-style-type: none">• Inversion and velocity modelling• Physics-informed machine learning• Uncertainty quantification and calibration• Gravity and lithospheric thermal modelling |
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