Comprehensive technical training on hydrocarbon exploration and production for postgraduate geoscience students from 1st to 11th July 2025

(Training report submitted by Aman Kumar Mishra, BANARAS HINDU UNIVERSITY, VARANASI)

Training coordinator: Dr. N. P. Singh

This report presents the technical sessions covered in the two-week online training program organized by Society of Petroleum Geophysicists (SPG) India for postgraduate students of SPG Student Chapters located at various universities/institutes. The training course was held between July 1st and July 11th, 2025. SPG identified distinguished academicians and industry experts to deliver lectures on a vast range of topics related to the geophysics and its application in oil exploration and production.

The two-week online course was very relevant and well-thought-out, particularly for geophysics and geology postgraduate students. The lectures covered both basic and advanced theories, spanning from seismic techniques, plate tectonics, well logging operations, reservoir characterization to non-conventional hydrocarbon exploration. Each session shed further light on practical knowledge and bridged the gap between academic study and actual applications in the oil and gas industry. The different sessions conducted are appended below.

Seismic methods and acquisition

Faculty: Mr. U. S. D. Pandey (Former Executive Director-CGS, ONGC)

An overview of seismic data acquisition and an introductory session on seismic methods made a good start to the training program. Mr. Pandey gave an overview of the fundamental ideas guiding the acquisition of seismic data. The unique methods and difficulties involved in acquiring seismic data on land and offshore were covered in detail in the lecture. The focus on new seismic technologies that are influencing exploration in the future were the main highlights. The participants valued the inclusion of real-world industry examples and the thorough comparison of onland and marine acquisition methodologies.

Seismic data processing and interpretation

Faculty: Dr. Naveen Mahadeva, DGM-Geophysics, ONGC, Dehradun

Dr. Naveen Mahadeva's session provided a very brief yet thorough discourse on the seismic method, including data acquisition and processing. For most of the participants, the description of the uphole survey was a novel and useful idea. Dr. Mahadeva explained the essential significance of velocity analysis in CDP gathers and gave a valuable overview of migration methods. The consecutive logical development and coherent organization of the presentation were commented upon as being especially effective in terms of comprehending the interrelated phases of seismic data processing.

Marine seismic data processing

Faculty: Mr. Rajnish Kr Yadav, Mr. Piyush Kumar Mishra, GEOPIC, ONGC

Mr. Rajnish Kumar Yadav and Mr. Piyush Kumar Mishra gave a two-part series of marine seismic data processing.

The *first part*, conducted by Mr. Yadav, covered the early part of the processing cycle. The most important subjects covered in the lecture were data Loading and reformatting, navigation merging, denoising, deghosting, first pass of velocity analysis, multiple attenuation, and ended with binning and offset regularisation. The step-by-step, practical dissection of each process was much appreciated for its lucidity.

The *second part*, by Mr. Mishra, picked up on the processing sequence, this time covering more sophisticated areas. The subject matter of this lecture included, RMS velocity analysis, the critical step of migration, post-migration gather conditioning, and post-stack processing. These two lectures together created a detailed understanding of the marine seismic data processing flow.

Seismic attributes for reservoir characterization

Faculty: Mr. Satinder Chopra, Samigeo, Canada

Mr. Satinder Chopra gave an informative lecture on the use of seismic attributes for reservoir characterization. The session processed different types of attributes such as post-stack and pre-stack attributes, coherence and curvature attributes, litho-fluid indicators like impedance, and spectral attributes. The topic proceeded to advanced techniques such as spectral decomposition and impedance inversion. The audience appreciated the step-by-step explanation, the information on advanced methodologies, and the employment of working examples and real applications.

Seismic data interpretation

Faculty: Dr. Hari Lal, Ex-ED, Head of Institute, KDMIPE, ONGC, Dehradun

Dr. Hari Lal delivered a masterclass on seismic data interpretation, ranging from basic concepts to sophisticated applications. The presentation described a complete interpretation workflow, beginning with geological and geophysical fundamentals. Next, it moved through structural and stratigraphic interpretation methods. The talk also included the utilization of seismic attributes, Direct Hydrocarbon Indicators (DHI), AVO modelling and analysis, and acoustic and elastic inversion, finally summarizing in a synopsis to combine these heterogeneous datasets.

Seismic amplitude analysis

Faculty: Mr. Hemant Kumar Dixit

Mr. Hemant Kumar Dixit's talk on *Seismic amplitude analysis: A historical perspective and emerging trends*, provided an interesting glimpse into the history and future of this vital discipline. The talk opened with the background of seismic data interpretation and then progressed to AVO attributes, seismic deterministic inversion, geostatistical inversion, and multi-azimuthal inversion. A major part was given over to emerging trends, which highlighted the necessity of combining rock physics and data-driven models. The historical approach gave a good background to learn about contemporary methods, and the lecture was able to link theoretical principles with practical applications.

Structural geology and seismic expression

Faculty: Dr. Jalla Nagaraju

The presentation by Dr. Jalla Nagaraju was about structural geology and seismic expression of different structural styles. Some of the core subjects were the basic components of a petroleum system, recognition of flat spots and bright spots in seismic data, and structural interpretation principles. The session outlined the mechanics of structural and stratigraphic hydrocarbon traps, as well as the fundamentals of migration. Some of the more advanced concepts like fault interpretation and stress regimes, thin-skinned and thick-skinned fold-and-thrust belts, detachments, and inversion tectonics were discussed in detail.

Vertical Seismic Profiling (VSP)

Faculty: Srilata Mohapatra and Dr. N. P. Singh

A comprehensive lecture on Vertical Seismic Profiling (VSP) was delivered by Mrs. Srilata Mohapatra, while the practical aspects were covered by Dr. N. P. Singh.

The lecture by Srilata Mohapatra included the history of VSP, typical survey geometries, and acquisition details, such as borehole deployment, energy sources, and downhole tools. The conversation also included imaging and fill-in surveys, pre-survey modelling, integration with surface seismic data, and production and drilling applications, and ended with a vision of future VSP technologies. Dr. N. P. Singh's lecture provided valuable hands-on contribution by addressing the demands of offset VSP survey setups and multi-level tool usage for solving thin layers. He described the 4C downhole processing technique and presented videos of actual VSP data acquisition in field conditions, which greatly contributed to the learning process.

Well logging principles and interpretation

Faculty (Basics): Mr. Sushil Kumar Maurya

Faculty (Interpretation): Mr. Sujay Thakur

Faculty (Advanced): Mr. Anurag Saxena

A three-part series gave a well-rounded education on well logging, from simple operations to sophisticated interpretation.

Mr. Sushil Kumar Maurya's presentation on *Basics of logging operations and safety* introduced to well logging,

its types, and its application in the E&P sector. The presentation discussed the borehole environment and a set of basic open-hole logs such as gamma ray, spontaneous potential, calliper, resistivity, neutron, density, and sonic logs. It also touched upon production logging, perforation, stuck-up conditions of tools, and important elements of hazard management and safety.

Next, Mr. Sujay Thakur spoke on the *Principles and interpretation of basic well logs*. Following a short history, the presentation elaborated the physical principles of the basic logs. Much of the lecture was spent on interpretation to arrive at important reservoir parameters such as volume of shale, porosity, and water saturation.

Finally, Mr. Anurag Saxena's lecture on *Advanced logs interpretation* session familiarized participants with advanced logging tools and methods. This encompassed NMR (Nuclear Magnetic Resonance), FMI (Formation Micro Imager), ECS (Elemental Capture Spectroscopy), DSI (Dipole Shear Sonic Imager), RT scanner, and dielectric logging tools. The session ended on an optimistic note by detailing the use of these advanced logs in all-around petrophysical analysis.

Reservoir Engineering and Geology

Faculty (Reservoir Eng.): Dr. Dipesh Chopra

Faculty (Tectonics): Mr. G. C. Katiyar

Dr. Dipesh Chopra delivered his talk on *Fundamentals of reservoir engineering*, defining the science and mathematics upon which the field is based. The session examined reservoir rock quality, recovery factors, capillary pressure, and multiple reservoir drive mechanisms. It also covered applied topics like waterflooding, Enhanced Oil Recovery (EOR), material balance analysis, and reservoir simulation, with a case study of the Ravva field.

Mr. G. C. Katiyar's presentation on *Plate tectonics and sedimentary basins of India* put hydrocarbon exploration in a broader context of geology. The lecture had a lucid progression, beginning with the evolution of the solar system and Earth, leading to the idea of Pangea, followed by elaborating the basics of plate tectonics, i.e., plate margins, cratons, and significant fault systems. This set the stage to understand the evolution of India's sedimentary basins.

Gravity and magnetic methods

Faculty: Mr. Manish Kumar, ONGC

Mr. Manish Kumar's lecture was on *Gravity and magnetic methods for hydrocarbon exploration*. It started with a general overview of Indian sedimentary basins and the reference ellipsoid followed by an explanation of the fundamentals of these potential field methods. For both gravity and magnetics, the physical principles, instrumentation, data processing, and response interpretation from geological bodies were discussed. The presentation was anchored with two case studies: gravity and magnetic modelling in the Muglad Basin, Sudan, and gravity modelling in the Vindhyan Basin, India.

Unconventional and tight reservoirs

Faculty: Mr. J.P. Dobriyal, E&D Directorate, ONGC

The last lecture was on *Unconventional and Tight Reservoirs* by Mr. J. P. Dobriyal. The talk covered the present world energy mix, the energy transition that is currently in progress, and the future of oil and gas exploration. It then took a close examination of unconventional resources, defining and characterizing the likes of shale oil, shale gas, coal bed methane (CBM), and gas hydrates. The main ideas presented were the physics of these special reservoir rocks and the exploration potential in them.

The whole training program was very well coordinated and conducted smoothly. Special thanks to *Dr. N. P. Singh*, Chief Training Coordinator, whose efforts made sessions timely and communication smooth. Thanks to *Ms. Swati Singh* and *Mr. Aakash Chuchra*, whose continuous help made day-to-day management and interaction with faculty and students highly efficient and structured.

Overall, the training was an enriching learning experience for us all. It broadened our technical knowledge and provided a better perspective of career opportunities in the energy industry. We eagerly await more such projects from SPG India in the future. This training was organised online, but it is strongly felt that the training will become more effective if it is organised in hybrid mode i.e., a mix of online and person mode.