

## PhD programme in Earth, Environmental and Resources Sciences

Instructor(s)	Pier Paolo Bruno, DiSTAR - UNINA
Course Title	Seismic Modeling and Imaging: A Numerical Workflow
Total Number of Hours	12
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### Course Description

This 12-hour laboratory provides a hands-on introduction to the numerical integration of structural geology and seismic imaging. Instead of treating seismic sections as "black boxes," doctoral students will learn to validate geological hypotheses by simulating the seismic response of complex subsurface structures. Using pre-configured MATLAB templates, the course covers a streamlined workflow: from the discretization of a geological cross-section into physical property grids to the generation of synthetic wavefields and final depth reconstruction. The primary objective is to equip researchers with the skills to critically assess seismic image reliability and identify common processing artifacts (e.g., velocity pull-ups, smiles). This is a practical toolkit for Ph.D. candidates to test the physical consistency of their structural interpretations, ensuring that interpreted geometries are supported by wave propagation physics and are not merely imaging noise.

### Course Contents

1. **From Sketches to Physical Grids** Numerical discretization of geological sections (faults, folds, unconformities) into discrete velocity and density models. Introduction to the 2D Acoustic Wave Equation.
2. **Seismic Forward Modeling** Generating synthetic shot gathers using Finite-Difference (FD) schemes. Students will analyze how geological complexity dictates seismic illumination, diffractions, and resolution limits.
3. **Depth Imaging via Reverse Time Migration (RTM)** Principles of structural reconstruction. Using the RTM "imaging condition" to focus seismic energy and correctly position dipping reflectors in the spatial domain.
4. **Velocity Sensitivity & Blind Test** Hands-on "stress-test" to recognize diagnostic artifacts (smiles, pull-ups) caused by inaccurate velocity models. Final workshop to validate an unknown structure through a guided imaging loop.

## Learning Outcomes

By the end of the course, doctoral students will be able to:

- Generate numerical simulations of seismic wave propagation through custom geological targets.
- Identify diagnostic imaging artifacts to distinguish real geological features from processing noise.
- Validate structural interpretations by testing their physical consistency through a modeling-to-imaging loop.

## Teaching Format

Practical laboratory sessions (70%) using pre-built MATLAB scripts, integrated with brief theoretical lectures (30%) and discussion of synthetic case studies.

## Essential Bibliography

- Claerbout, J. F., *Imaging the Earth's Interior*, Blackwell Scientific Publications, 1985.
- Lines, L. R., & Newrick, R. T. (2004). *Fundamentals of geophysical interpretation*. Society of Exploration Geophysicists.

## Assessment Method

Active participation in laboratory exercises and a final in-class discussion of the results obtained during the Blind Test workshop.