

Revised PETROBRAS OUTLINE

Seismic Modeling: Use of seismic modeling tools in hydrocarbon exploration. The emphasis will be on understanding the strengths and weaknesses of alternative modeling techniques, and the use of modeling to understand elastic wave propagation phenomena. This course will have a heavy hands-on lab component and will be taught in conjunction with Seismic Wave and Ray Theory.

Lecture Outline

1. Introduction:
 - a. Objectives of seismic modeling
 - b. Limits to vertical and lateral resolution (overview)
 - c. Two modeling case studies – the 2-D Marmousi2 and the 3-D EAGE/SEG salt model
2. 3-D physical (scale) models
 - a. what scales and what doesn't
 - b. designing and constructing a 3-D physical model
 - c. advantages and limitations
3. The hierarchy of numerical modeling algorithms – capabilities and limitations
 - a. the convolutional model
 - b. asymptotic ray theory
 - c. eikonal solvers
 - d. semi-analytic (flat layer) solutions: reflectivity methods
 - e. integral equation techniques: Kirchhoff modeling
 - f. numerical 2-D and 3-D solutions: finite difference, finite element, and pseudospectral modeling
4. Modeling alternative acquisition programs (illumination studies)
 - a. Surface seismic
 - b. Multicomponent
 - c. VSP
 - d. OBC
 - e. Cross-borehole
5. Understanding elastic wave phenomena through modeling
 - a. AVO effects and thin bed tuning
 - b. Reflections and diffractions
 - c. Head waves and diving waves
 - d. Ground roll and other interface waves
 - e. Multiples and reverberating refractions
 - f. Effects of topography and weathering zones
 - g. Effects of intrinsic vs geometrical attenuation
 - h. Limits to vertical and lateral resolution (revisited)
6. Modeling as a processing tool
 - a. Seismic migration
 - b. Acoustic impedance inversion
 - c. Least-squares migration

- d.** Waveform tomography
- 7.** Wrap-up and summary

Lab Outline

- 1.** vertical ray convolutional modeling using GX-II
- 2.** normal incident ray convolutional modeling using GX-II
- 3.** 2-D modeling using GX-II
- 4.** 3-D modeling using GX-III
- 5.** Interpretation of 3-D physical model events
- 6.** 3-D traveltimes solution using FMEikonal (SEP software)
- 7.** reflectivity modeling using Solid
- 8.** 3-D Kirchhoff modeling (AGL software)
- 9.** 2-D acoustic modeling using finite differences (AGL software)
- 10.** The generation, display, and use of snapshots
- 11.** 2-D elastic modeling using pseudospectral method (AGL software)
- 12.** The generation, display, and use of multicomponent snapshots