**SHORT COURSE AT NTNU, TRONDHEIM, 15-19 NOVEMBER 2004**

# Seismic ray theory for anisotropic media: Green's function calculation, map migration, and velocity estimation


## Lecturer: Einar Iversen, Norsar


*The course is aimed at researchers, doctorate students and geophysisists in the industry. Course fee for industrial participants is NOK5000 (lectures only). For more information, contact professor Bjørn Ursin (bjornu@ipt.ntnu.no)*

## Lecture Program

### Monday 15 November

RAY THEORY FOR ARBITRARILY ANISOTROPIC MEDIA
Review of ray modelling applications. Basic concepts related to wave propagation in anisotropic media.
Construction of anisotropic velocity models including interfaces. User parameters. Tilted and rotated anisotropy.
Kinematic and dynamic ray tracing in a continuous medium with arbitrary anisotropy.
Kinematic and dynamic ray tracing across an interface separating two arbitrarily anisotropic media.
Ray propagator matrices. Traveltime approximations.
Ray amplitudes. Reflection/transmission coefficients. Geometric spreading. Phase shift due to caustics.

### Tuesday 16 November

SIMPLIFIED ANISOTROPIC CASES. FORWARD MODELLING BY THE WAVEFRONT CONSTRUCTION METHOD.
Rays confined to a symmetry plane. Out-of-plane geometric spreading.
Ray theory for a VTI medium.
Weak-anisotropy approximations.
P-wave and S-wave Green's function formulations.
The wavefront construction (WFC) method.
Theory of normal-incidence rays. Zero-offset modelling by one-way wavefront construction.

### Thursday 18 November

SHEAR-WAVE SPLITTING. MAP MIGRATION. RAY PERTURBATION THEORY.
Shear-wave splitting. The quasi-isotropic approach.
The common (anisotropic) ray approach.
The principles of map migration. Zero-offset map migration based on normal-incidence rays and image rays.
Isochron rays. Finite-offset map migration.
Ray perturbation theory. Perturbation of traveltimes, ray points, and slowness vectors.
Perturbation of amplitude-related quantities (reflection/transmission coefficients, polarization vectors)

### Friday 19 November

SENSITIVITY ANALYSIS AND VELOCITY MODEL UPDATING
Velocity model updating based on misfit functions associated to time and depth domain.
Perturbation theory for seismic isochrons.
Velocity rays. Kirchhoff image propagation for anisotropic media.
North Sea example: Estimation of VTI parameters based on PP and PS traveltimes.