Calculating both S waves in weakly anisotropic structures using coupling ray theory along a single ray

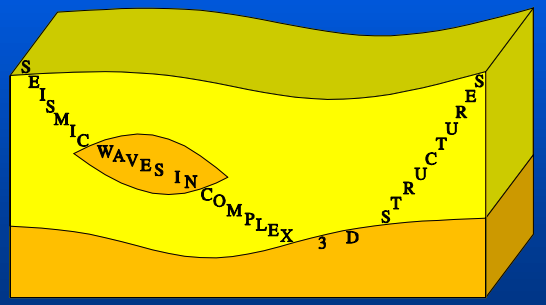
Petr Bulant & Luděk Klimeš

Charles University in Prague,

Department of Geophysics,

Faculty of Mathematics and Physics, Prague, Czech Republic, Europe

Consortium
“Seismic Waves in Complex 3-D Structures”
(http://sw3d.cz).

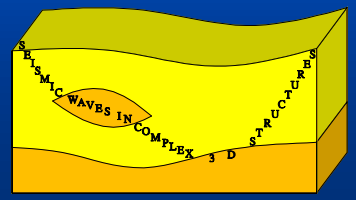


Coupling and splitting of S waves in an anisotropic medium

Isotropic ray theory

Anisotropic ray theory

Coupling ray theory

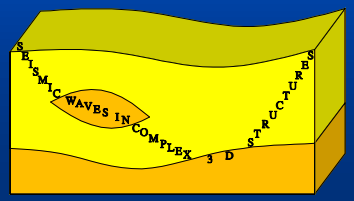


Isotropic ray theory

- assumes equal velocities of both S waves => 1 S wave ray
- S-wave polarization vectors do not rotate about the ray
- applicable to isotropic and very weakly anisotropic media

Anisotropic ray theory

Coupling ray theory



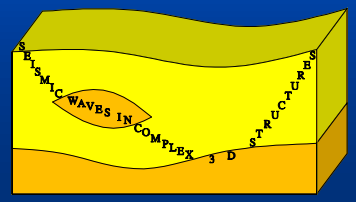
Isotropic ray theory

- assumes equal velocities of both S waves => one S wave ray
- S-wave polarization vectors do not rotate about the ray
- applicable to isotropic and very weakly anisotropic media

Anisotropic ray theory

- assumes both S waves strictly decoupled => two S1 and S2 rays
- S-wave polarization vectors coincide with the eigenvectors of the Christoffel matrix and may rotate rapidly about the ray
- always applicable to P waves
- applicable to S waves in strongly anisotropic media

Coupling ray theory

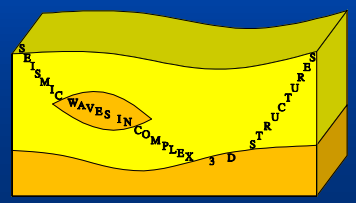


Isotropic ray theory

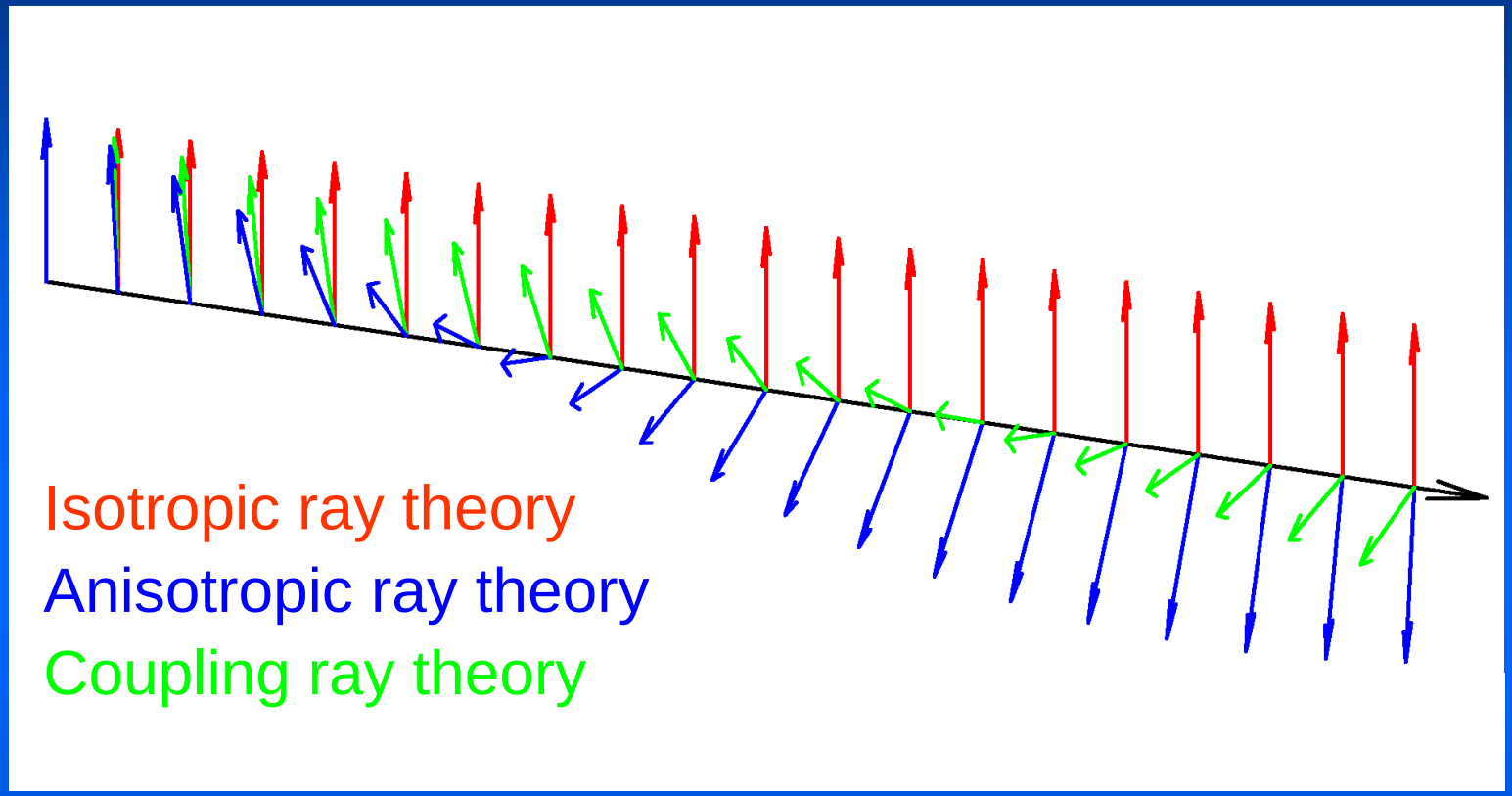
Anisotropic ray theory

Coupling ray theory (Coates & Chapman 1990)

- coupled frequency-dependent S waves calculated along one reference ray
- S-wave polarization vectors tend to remain unrotated about the ray, but are partially attracted by the rotation of the eigenvectors of the Christoffel matrix
- applicable to isotropy and to all degrees of anisotropy
- low-frequency limit: Isotropic ray theory
- high-frequency limit: Anisotropic ray theory

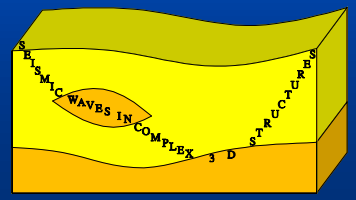


S-wave polarization vector along a ray:

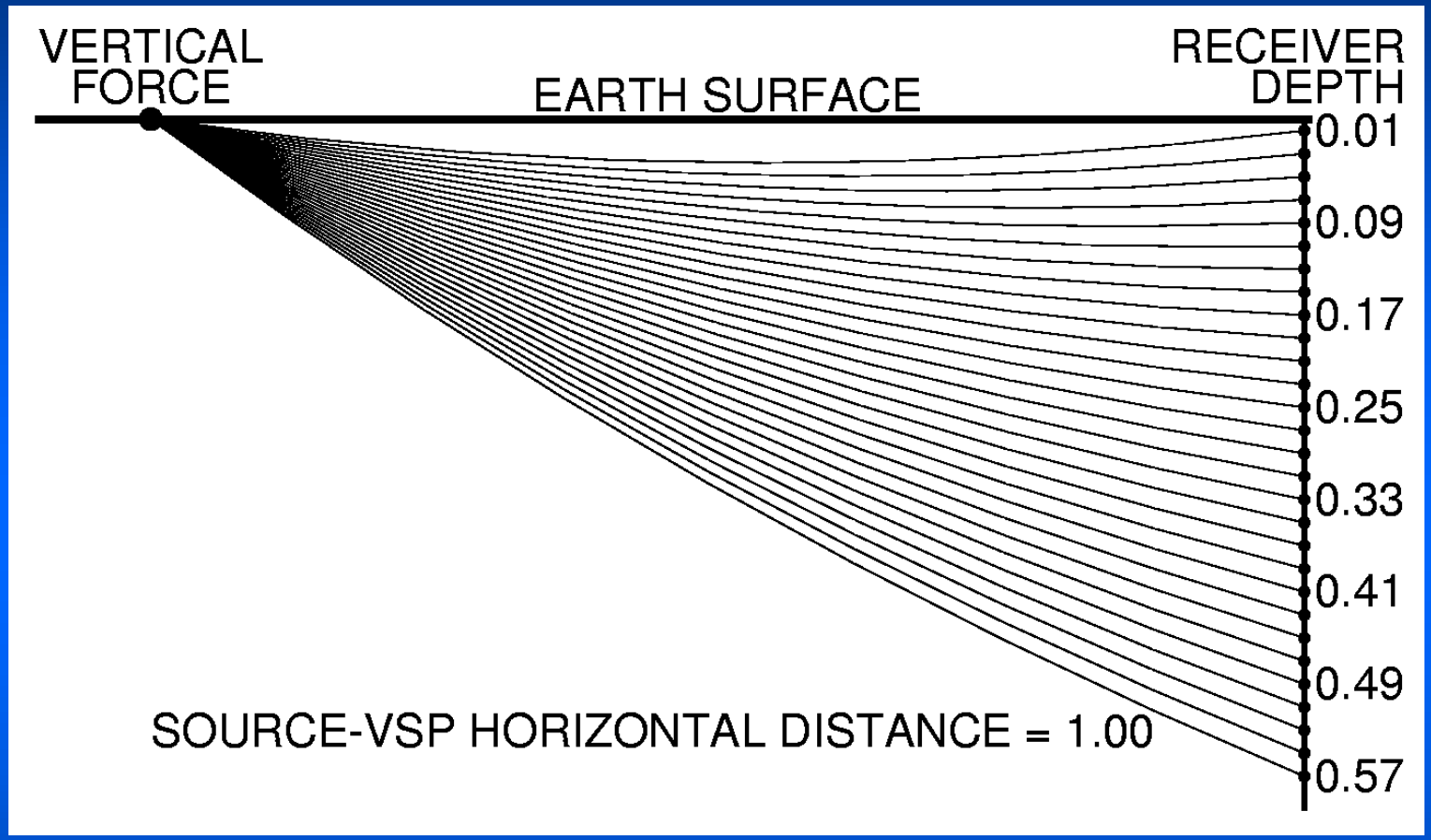


Numerical example

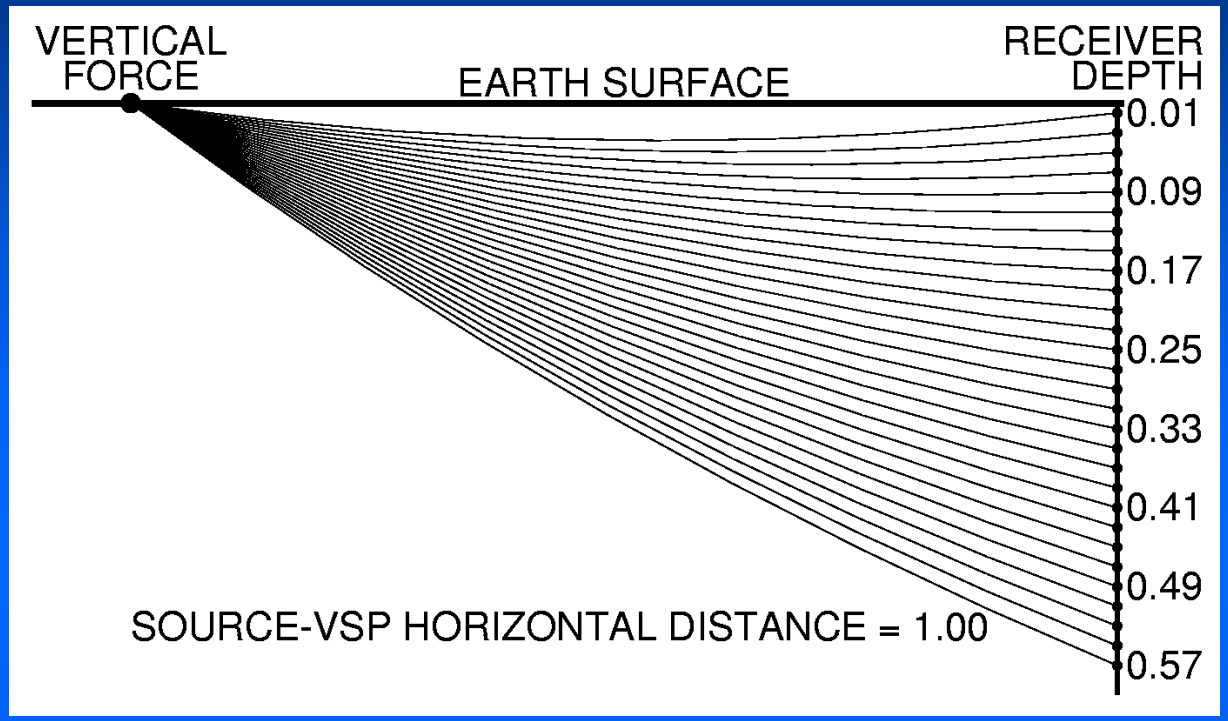
Synthetic seismograms calculated by the three methods in vertically heterogeneous 1-D models of different degrees of anisotropy.

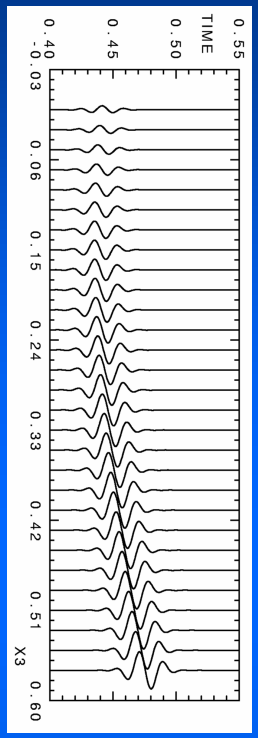


Vertically heterogeneous 1-D anisotropic models



Vertically heterogeneous 1-D anisotropic models

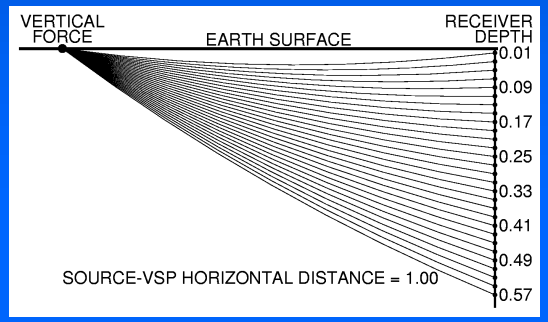




Models	QI0	QIH	QI1	QI2	QI4
S-wave anisotropy:	0%	1.7%	3.4%	6.7%	13.1%

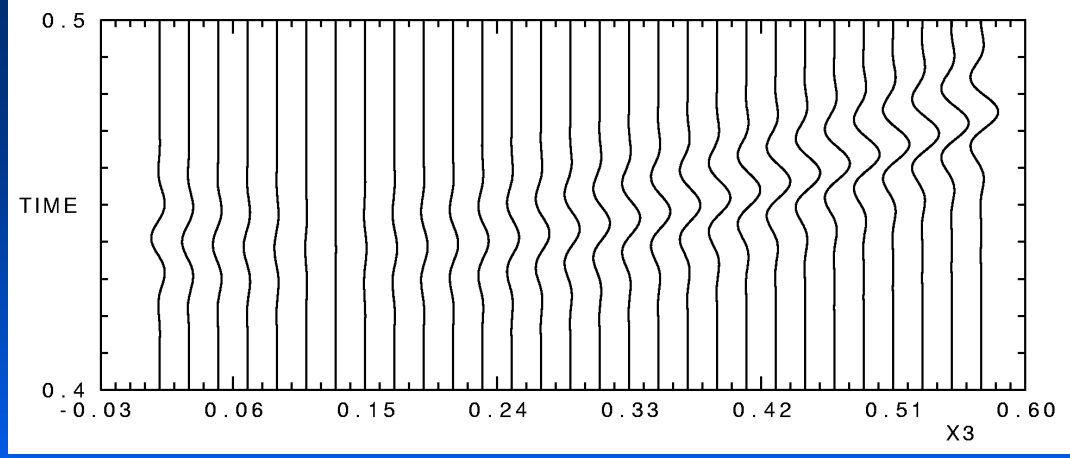
Isotropic ray theory seismograms in model QIH (calculated in QI0)

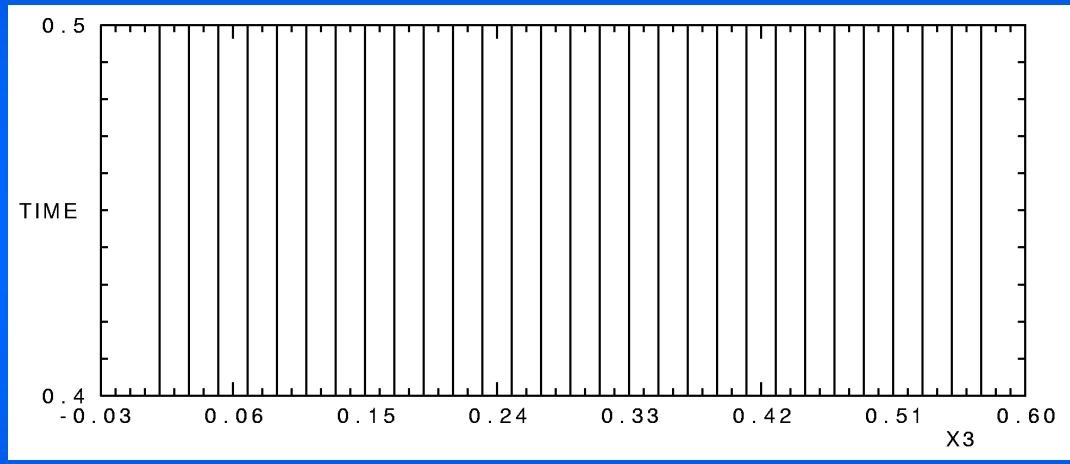
radial

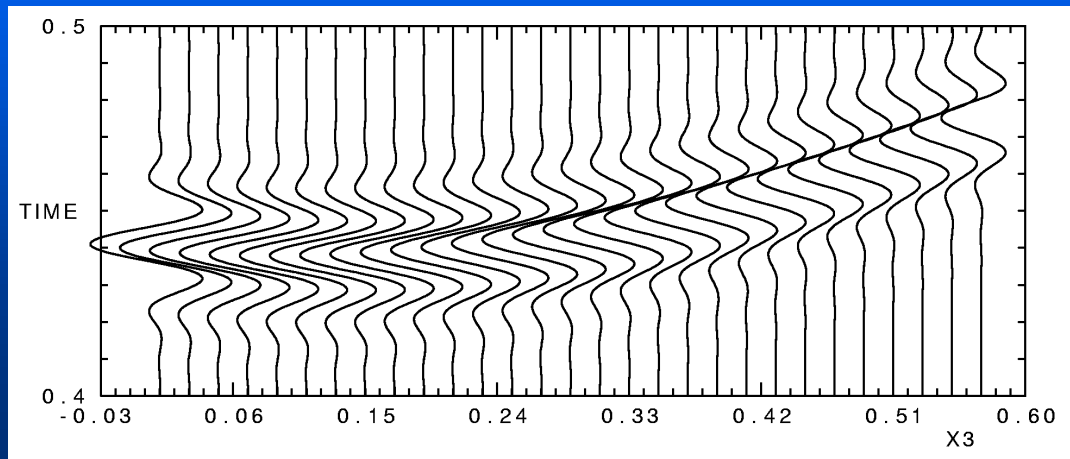


transverse

vertical

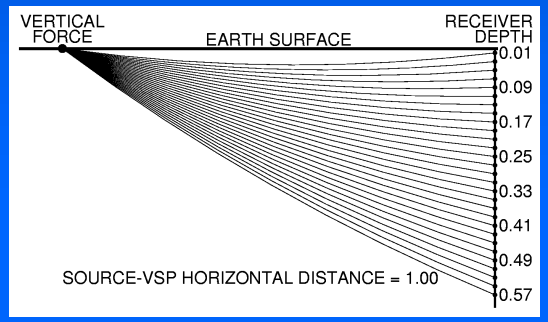






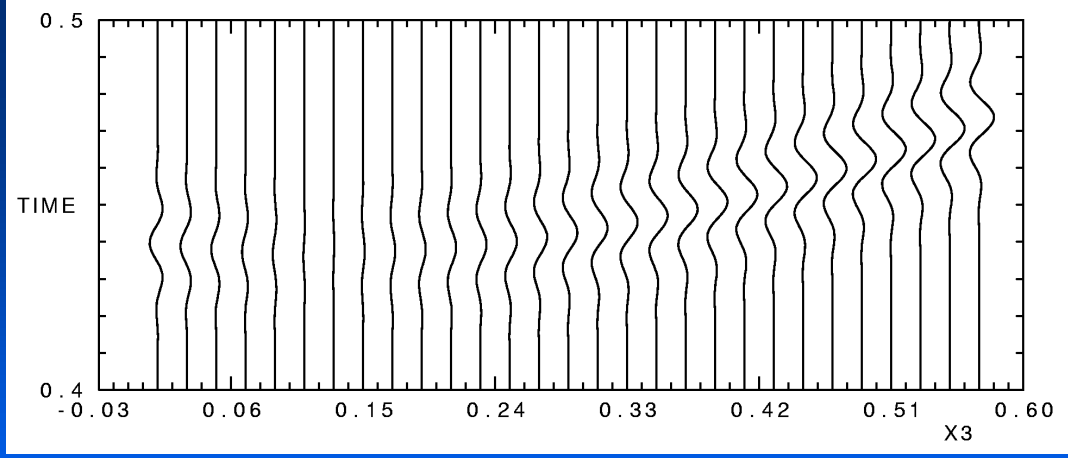
Anisotropic ray theory seismograms in model QIH

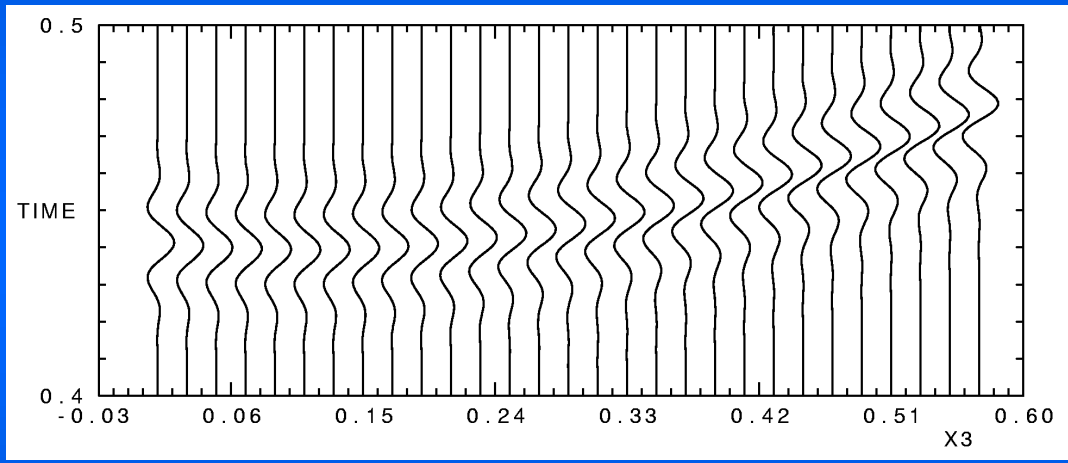
radial

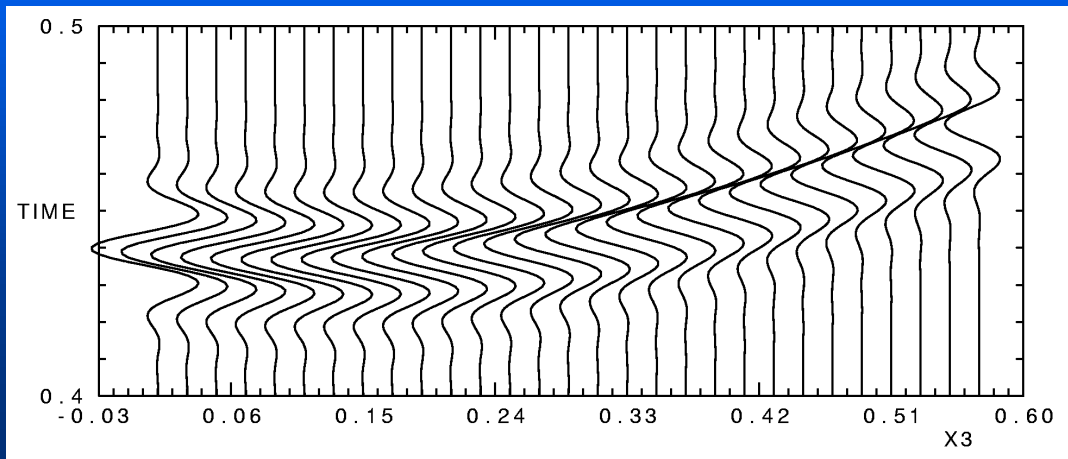


transverse

vertical

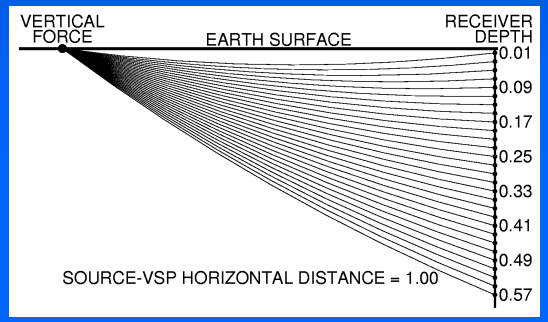






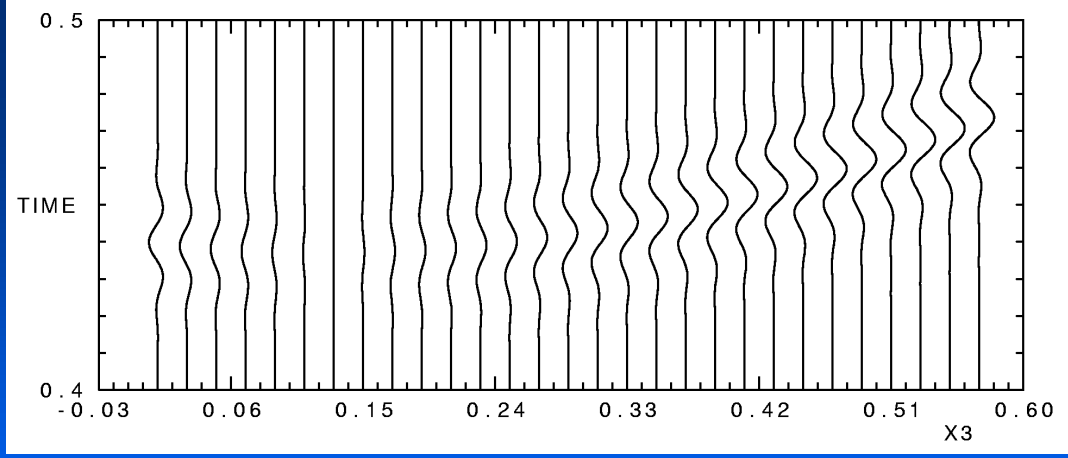
Coupling ray theory seismograms in model QIH

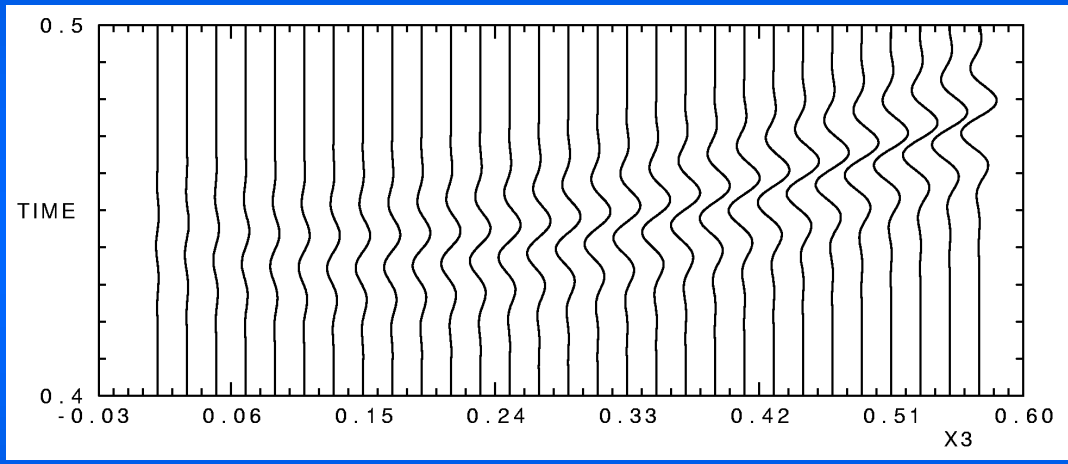
radial

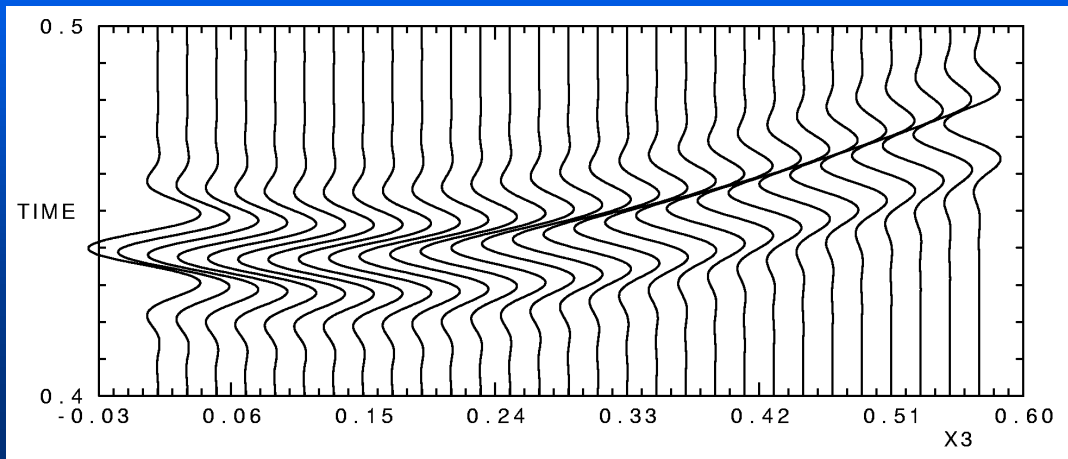


transverse

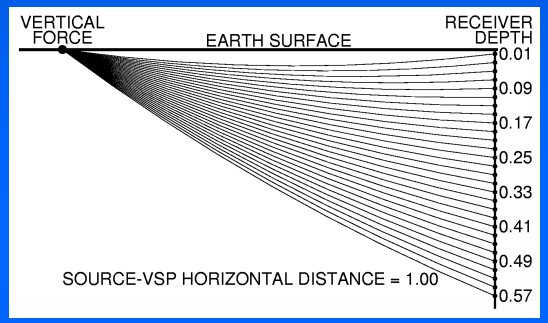
vertical



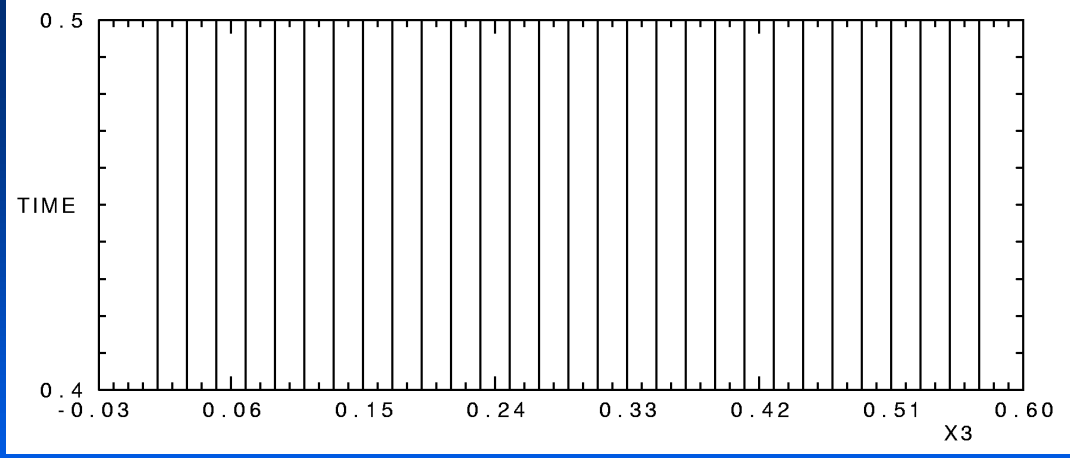




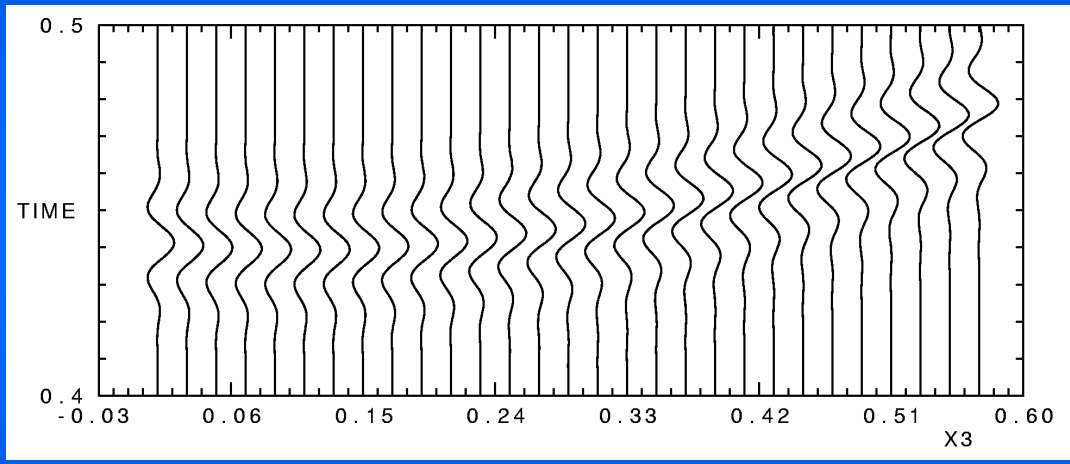
Seismograms in model QIH transverse component



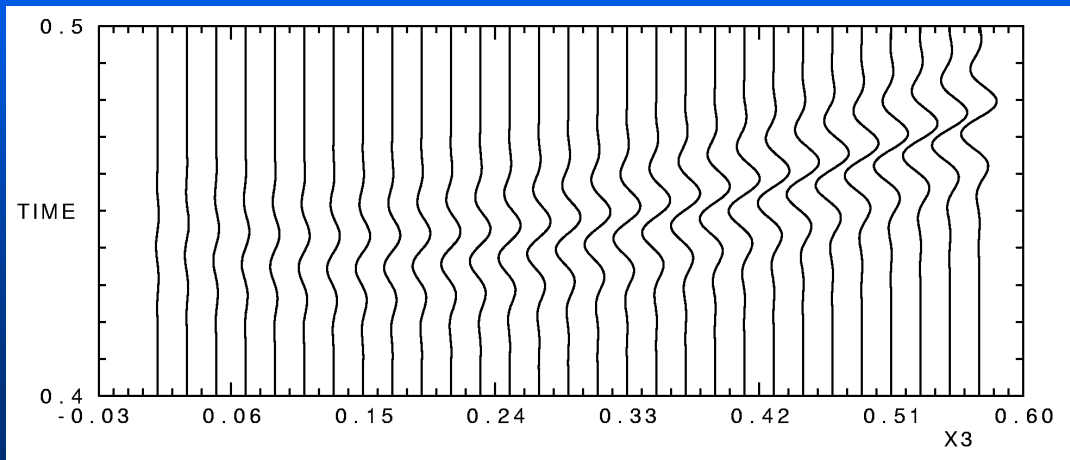
Isotropic



Anisotropic



Coupling



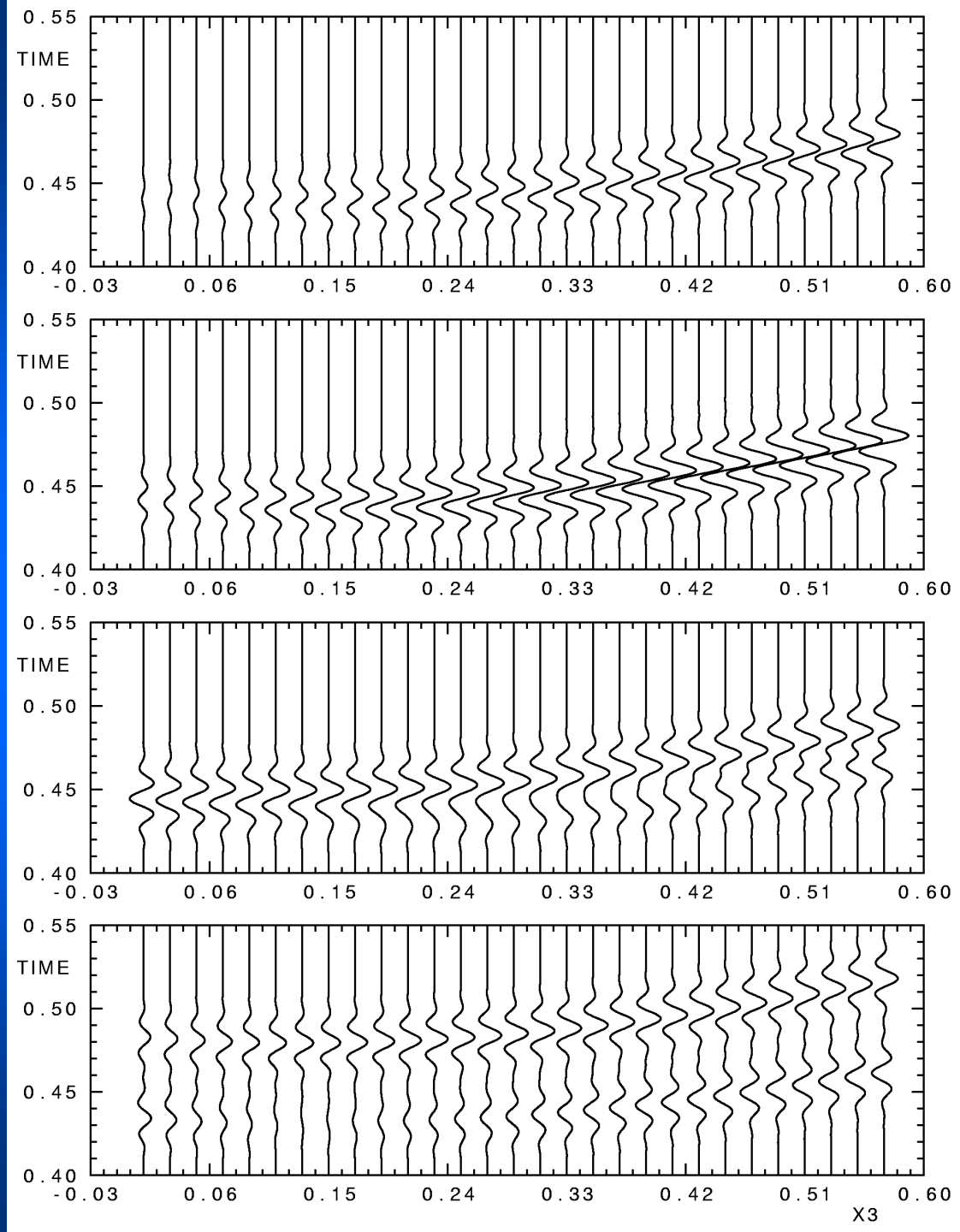
Coupling ray theory seismograms, transverse component

QIH

QI1

QI2

QI4



Coupling ray theory seismograms,

transverse component

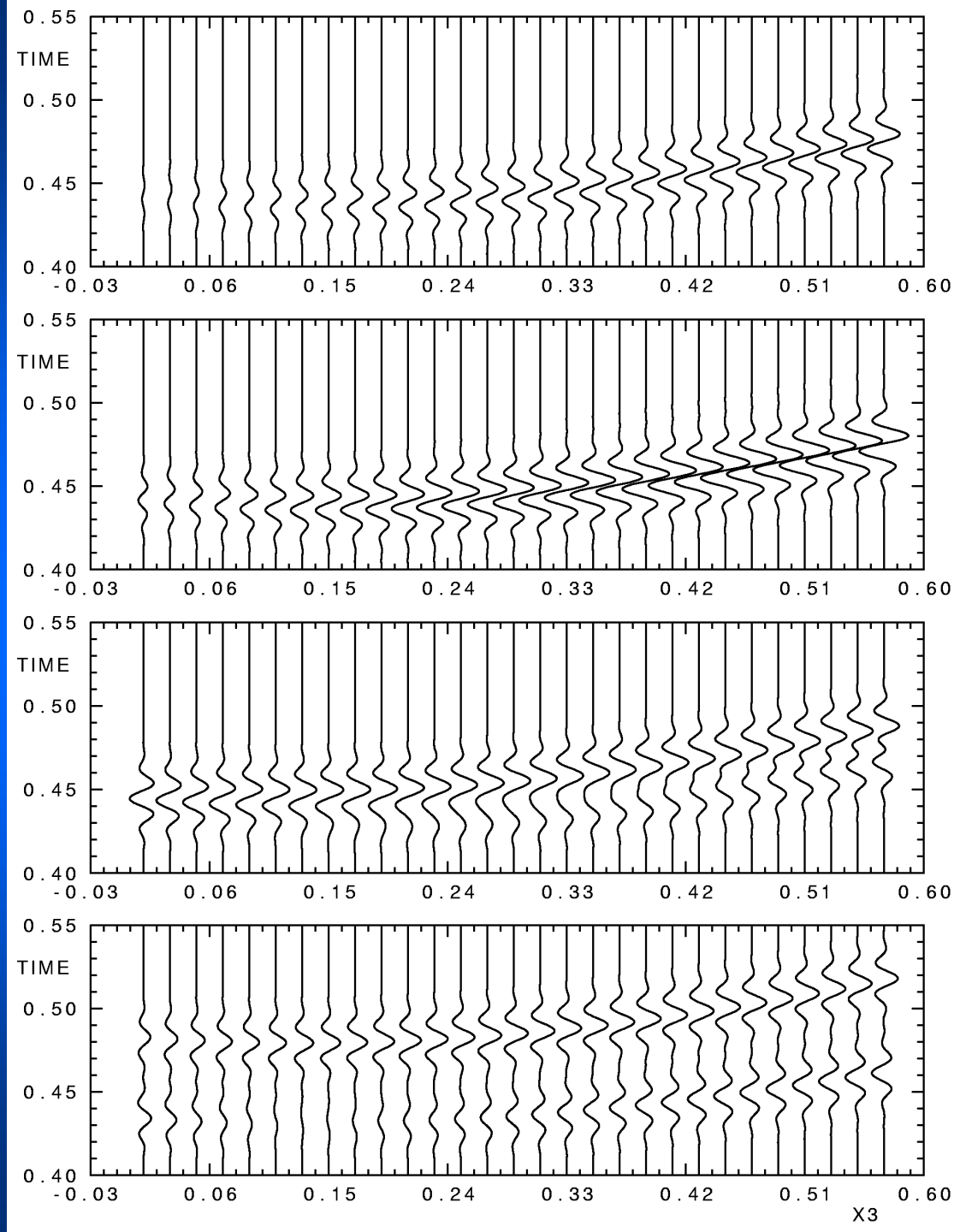
QIH

rotation of polarization

QI1

QI2

QI4



Coupling ray theory seismograms,

transverse component

QIH

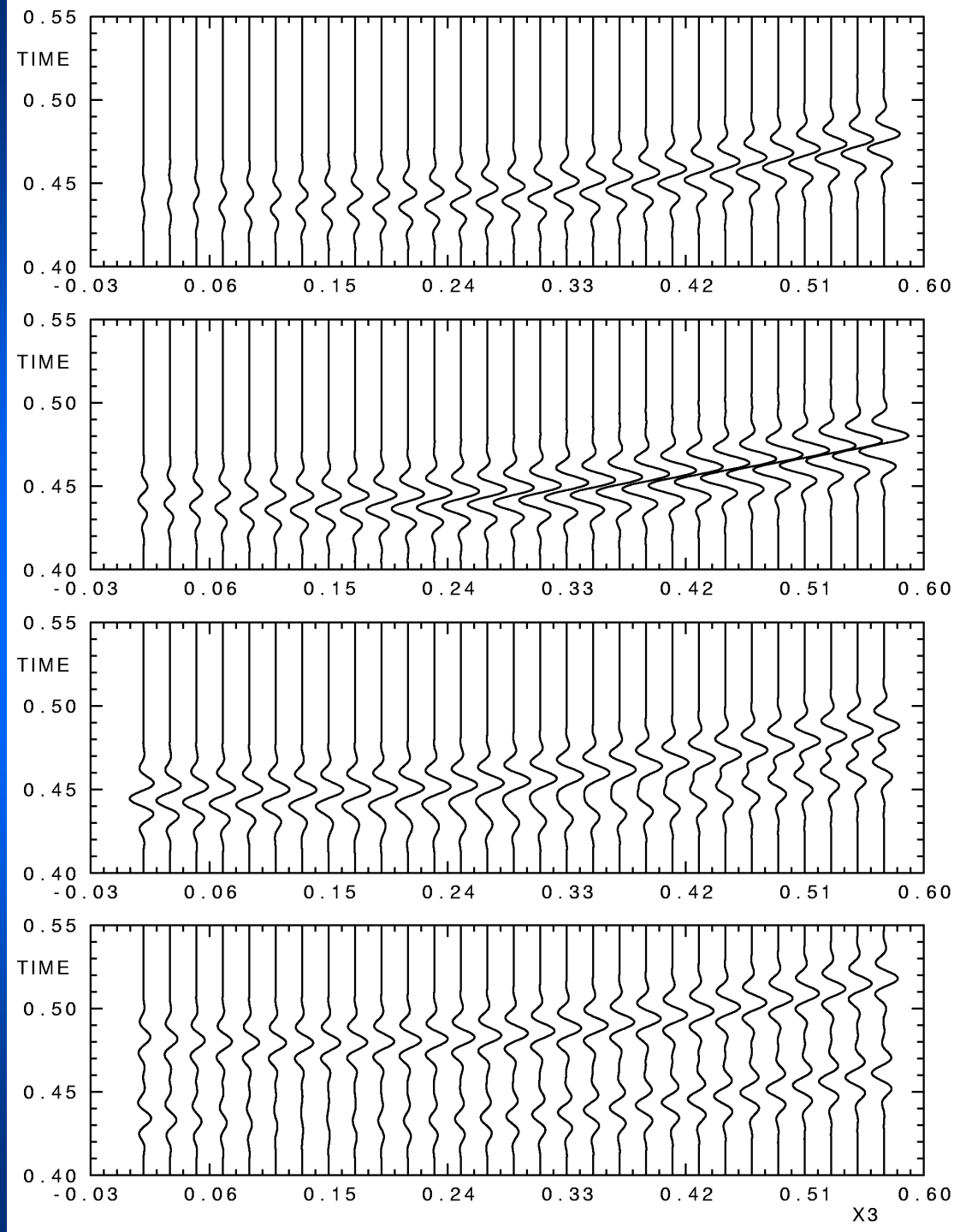
rotation of polarization

QI1

QI2

shear-wave splitting

QI4



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- Coupling ray theory is easy to apply
- For both S waves, only one common reference ray is needed (lower computational costs, no problems with S-wave singularities)
- Coupling ray theory may be derived from coupling ray series similarly as standard anisotropic ray theory from standard ray series

Acknowledgements

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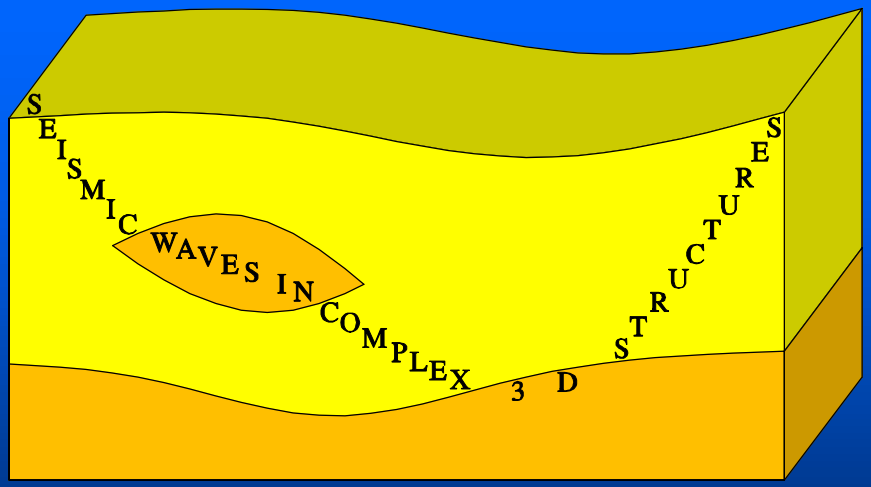
- Grant Agency of the Czech Republic Contract P210/10/0736
- Ministry of Education of the Czech Republic within research project MSM0021620860
- Consortium “Seismic Waves in Complex 3-D Structures”



(http://sw3d.cz)