KIRCHHOFF DEPTH MIGRATION IN ANISOTROPIC MODELS WITH A CURVED INTERFACE

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We approximate the "recorded wave field" by ray-theory synthetic seismograms. Then we apply ray-based Kirchhoff prestack depth migration to calculation of migrated sections in 2-D and 3-D simple anisotropic velocity models.

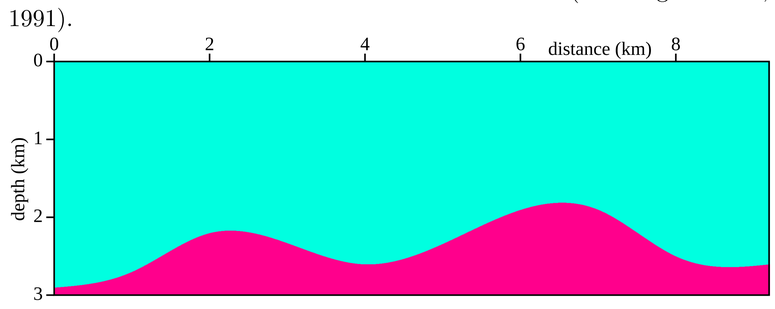
Each velocity model is composed of two homogeneous layers separated by one curved interface. We use different types of anisotropy in the upper layer.

Computation of the **recorded wave field** in the models is performed using the ANRAY software package (Gajewski & Pšenčík, 1990). Two-point rays are calculated for reflected P-wave in models with isotropy (ISO), transversely isotropic media with a horizontal symmetry axis (HTI), triclinic anisotropy (TA) and special case of monoclinic anisotropy (MA) in the upper layer.

We use MODEL, CRT, FORMS and DATA packages for the Kirchhoff prestack depth **migration** (Červený, Klimeš & Pšenčík, 1988; Bulant, 1996). The velocity models for migration are homogeneous.

We test Kirchhoff prestack depth migration in two ways: *a)* the anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration, *b)* the anisotropy used for computation of the recorded wave field **differs** from the anisotropy used for migration (for details see Bucha, 2010).

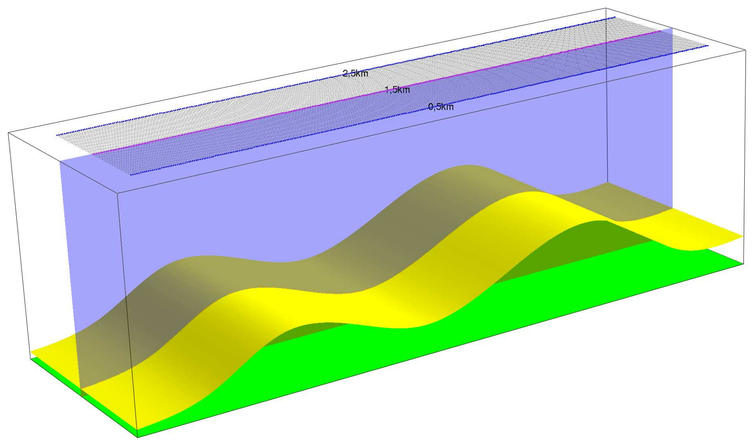
The dimensions of the velocity models and measurement configurations are derived from the Marmousi model and dataset (Versteeg & Grau, 1991).



One profile line is used for 2-D calculations. The first shot is at 3 km, the last shot is at 8.975 km, distance between shots is 0.025 km, the depth of shots is 0.008 km. The total number of shots is 240. The number of receivers per shot is 96, the first receiver is at offset 2.575 km left of shot location, the last receiver is at offset 0.2 km left of shot location, the distance between receivers is 0.025 km, the depth of receivers is 0 km.

The 3-D model is simply derived from the 2-D model by extension in the perpendicular direction. The 3-D measurement configuration consists of 81 parallel profile lines.

The measurement configuration along each profile line is the same as for the 2-D measurement. The distance between parallel profile lines is 0.025 km. We also test measurement configuration with twice greater line step 0.05 km (41 profile lines).

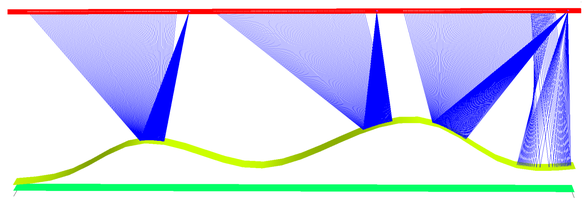


We compute and stack migrated sections in 2-D plane (blue) located at the middle of the shot-receiver configuration.

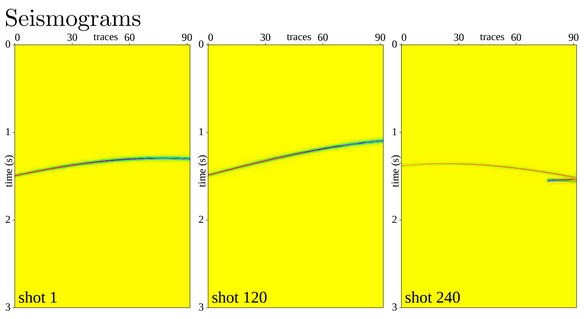
Isotropy (ISO)

P-wave velocity in the upper layer $V_p = 2.5$ km/s

Two-point rays for selected shots 1, 120, 240

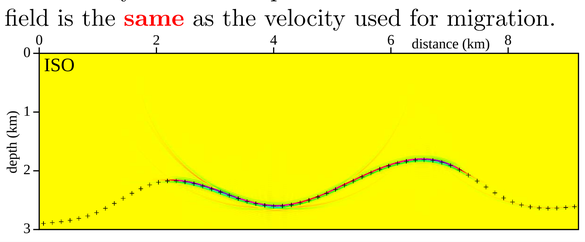


Seismograms



Stacked migrated section in 2-D model

The velocity used for computation of the recorded wave field is the **same** as the velocity used for migration.

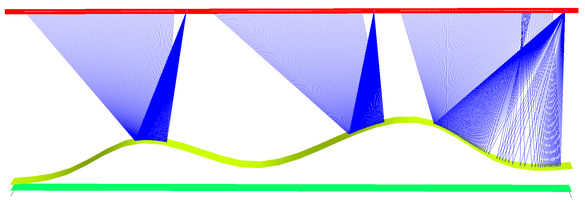


Transversely isotropic media with a horizontal symmetry axis (HTI)

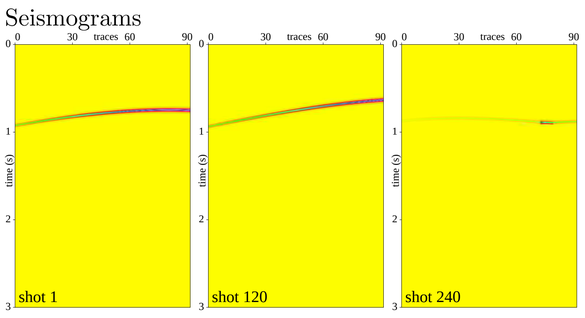
representing a medium with aligned thin dry cracks (Shearer & Chapman, 1989). Anisotropy of P waves is 24%. Reflected two-point rays are situated in the 2-D plane. Matrix of elastic parameters is defined by a table

$$\begin{pmatrix} 11.91 & 4.4 & 4.4 & 0. & 0. & 0. \\ & 19.11 & 6.35 & 0. & 0. & 0. \\ & & 19.11 & 0. & 0. & 0. \\ & & & 6.38 & 0. & 0. \\ & & & & 5.1 & 0. \\ & & & & & 5.1 \end{pmatrix}.$$

Two-point rays for selected shots shots 1, 120, 240

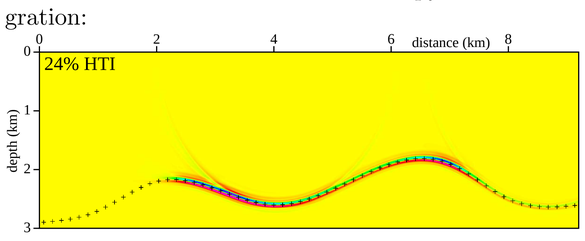


Seismograms

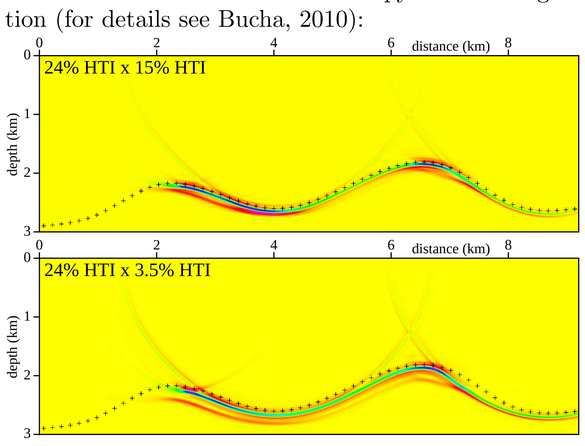


Stacked migrated sections in 2-D model

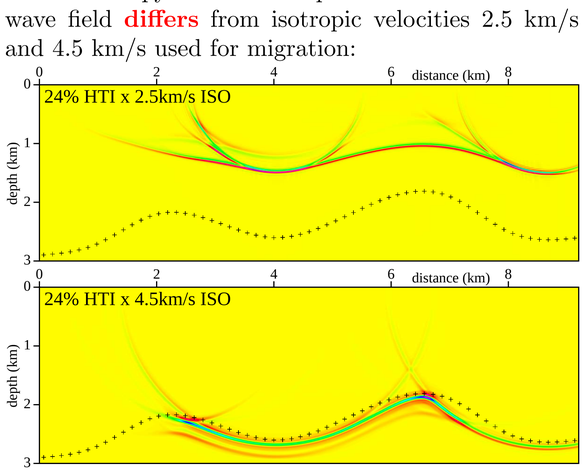
The anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration:



The anisotropy used for computation of the recorded wave field **differs** from the anisotropy used for migration (for details see Bucha, 2010):



The anisotropy used for computation of the recorded wave field **differs** from isotropic velocities 2.5 km/s and 4.5 km/s used for migration:



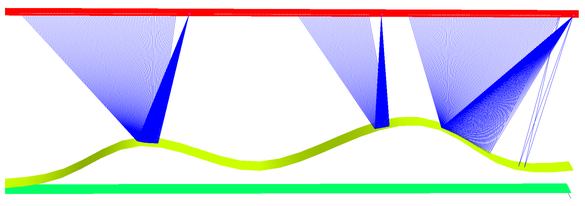
The migrated interface is shifted and deformed more by wrong guess of isotropic velocity than wrong guess of HTI anisotropy in the model used for migration.

Triclinic anisotropy (TA)

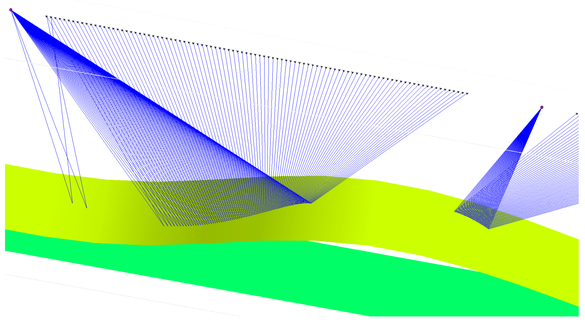
representing dry Vosges sandstone (Mensch & Rasolofosaon, 1997). Reflected two-point rays propagate in **3-D** volume. Matrix of elastic parameters is defined by a table

$$\begin{pmatrix} 10.3 & 0.9 & 1.3 & 1.4 & 1.1 & 0.8 \\ & 10.6 & 2.1 & 0.2 & -0.2 & -0.6 \\ & & 14.1 & 0.0 & -0.5 & -1.0 \\ & & & 5.1 & 0.0 & 0.2 \\ & & & & 6.0 & 0.0 \\ & & & & & 4.9 \end{pmatrix}.$$

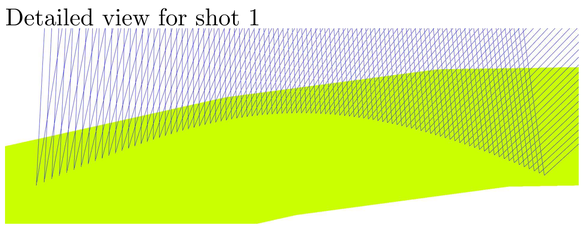
Two-point rays for selected shots 1, 120, 240



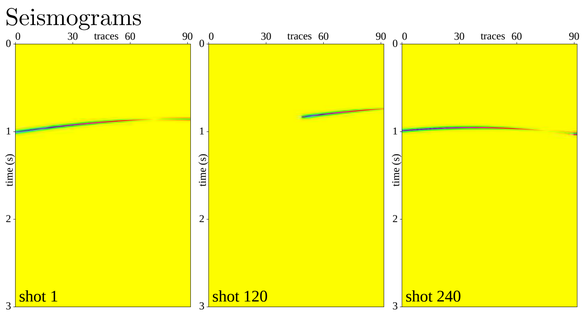
Detailed view for shots 240 and 120



Detailed view for shot 1

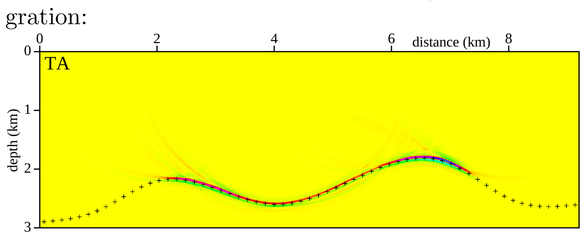


Seismograms



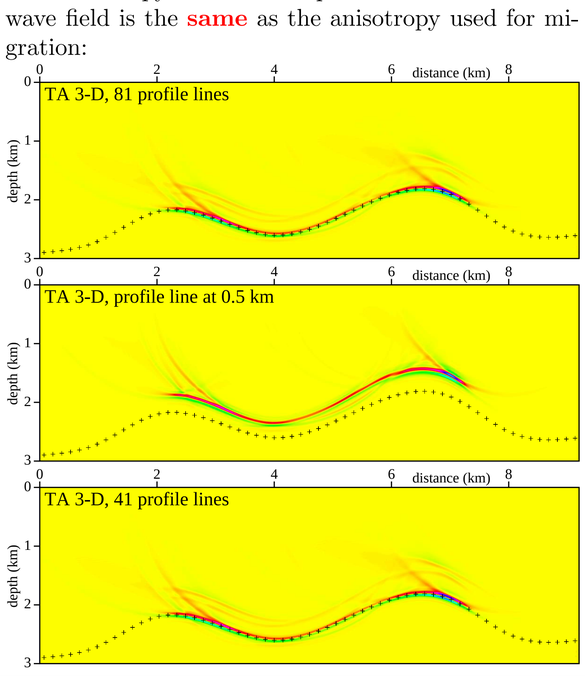
Stacked migrated sections in 2-D model

The anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration:



Stacked migrated sections in 3-D model

The anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration:

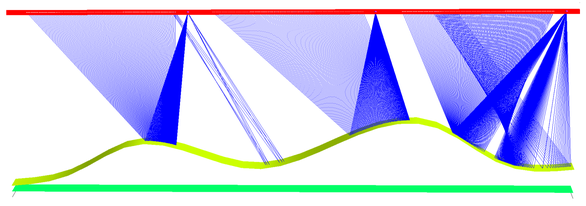


Monoclinic anisotropy (MA).

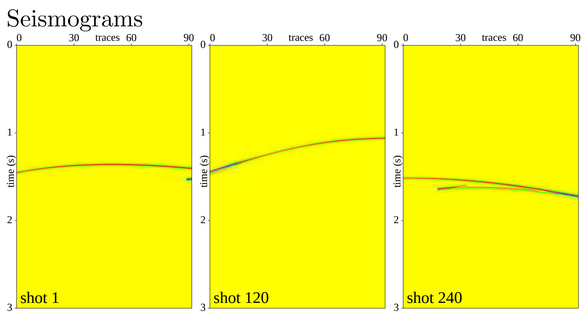
Reflected two-point rays are situated in 2-D plane. Matrix of elastic parameters is defined by a table

$$\begin{pmatrix} 4 & -2 & 4 & 0 & 1 & 0 \\ & 6 & -2 & 0 & 0 & 0 \\ & & 6 & 0 & 1 & 0 \\ & & & 2 & 0 & 0 \\ & & & & 2 & 0 \\ & & & & & 2 \end{pmatrix}.$$

Two-point rays for selected shots 1, 120, 240

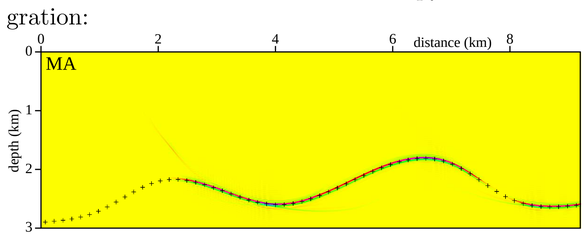


Seismograms

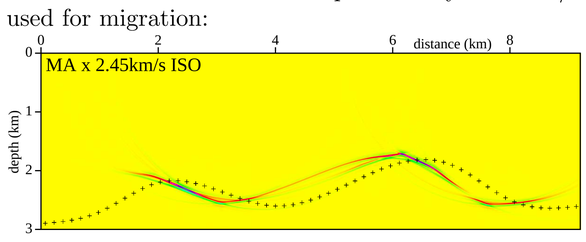


Stacked migrated sections in 2-D model

The anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration:

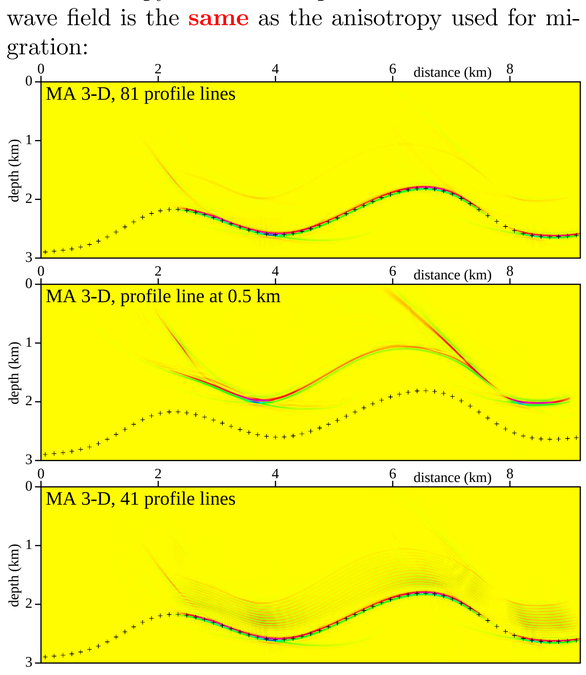


The anisotropy used for computation of the recorded wave field **differs** from isotropic velocity 2.45 km/s used for migration:



Stacked migrated sections in 3-D model

The anisotropy used for computation of the recorded wave field is the **same** as the anisotropy used for migration:



The migrated section computed with 0.050 km step (41 profile lines) for monoclinic anisotropy contains greater residua of individual sections used for stacking than migrated section computed for triclinic anisotropy.

Acknowledgments

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