Определение отражательной характеристики среды и наклонов границ путем векторной инверсии

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Determination of the Reflectivity and Boundary Dips by Means of the Vector Inversion Method

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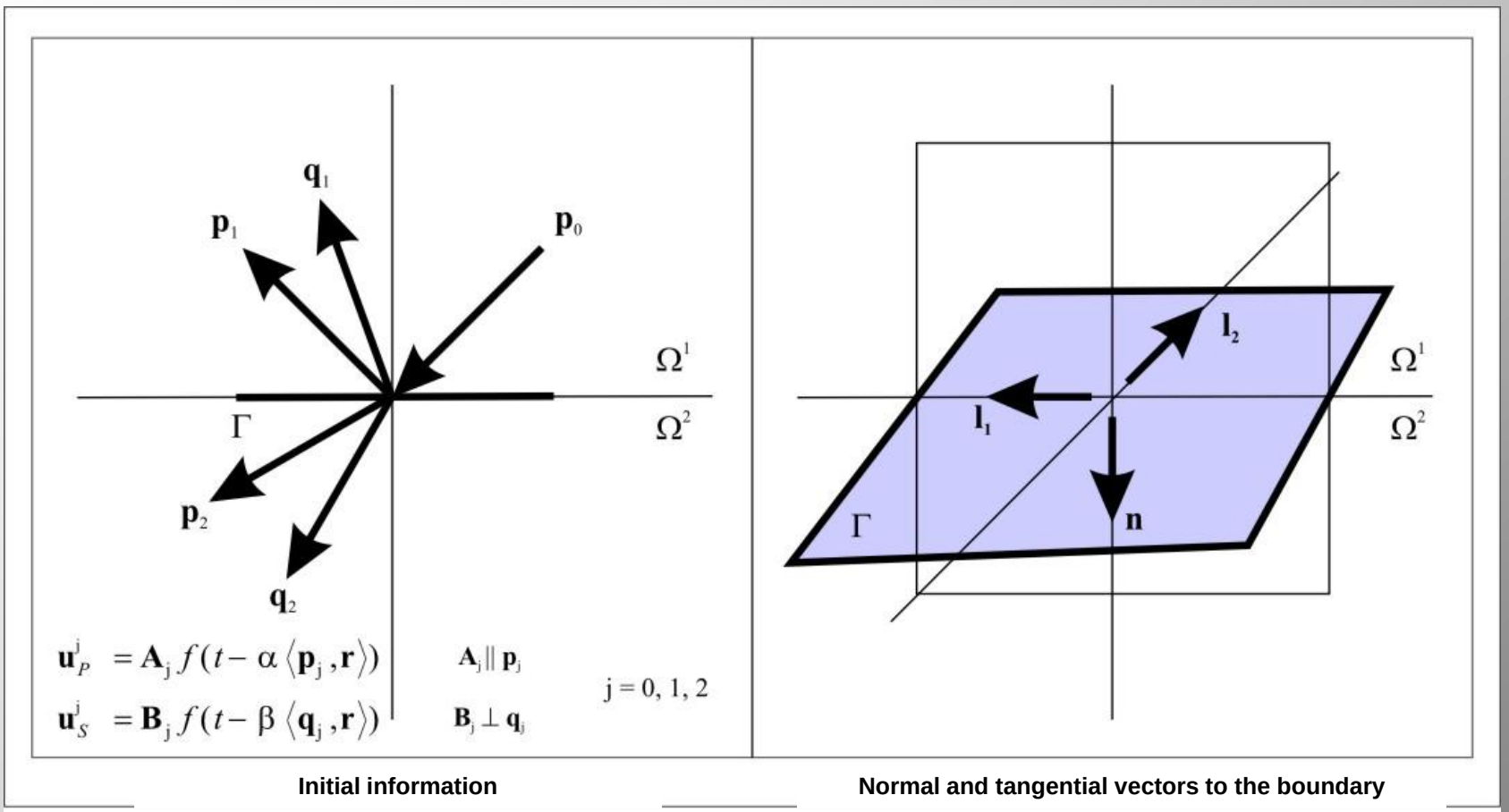
Statement of the problem



Initial information

Normal and tangential vectors to the boundary

Scheme of P wave incidence

Statement of the problem

$$\Gamma = \Omega^1 \cap \Omega^2, \quad \mathbf{n} \perp \Gamma, \quad \mathbf{l} \perp \mathbf{n}:$$

1) $$[(\mathrm{grad}\mathbf{u})\mathbf{l}]_\Gamma = 0 \quad \Rightarrow \quad \mathbf{n}, \quad \mathbf{d} = \{d_j\}_{j=1,2,3},$$

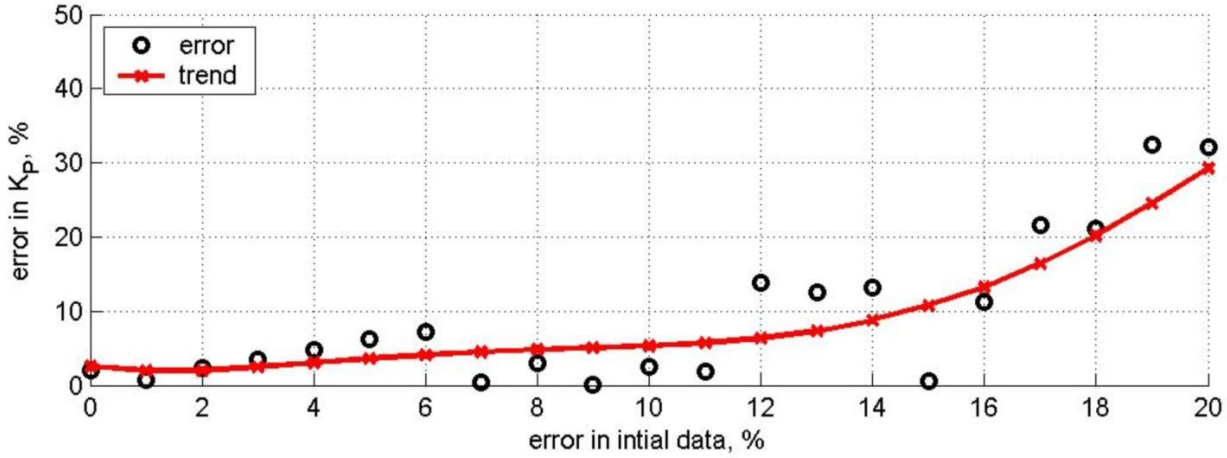
$$d_1 = v_P^1 / v_P^2, \quad d_2 = v_P^1 / v_S^1, \quad d_3 = v_P^1 / v_S^2.$$

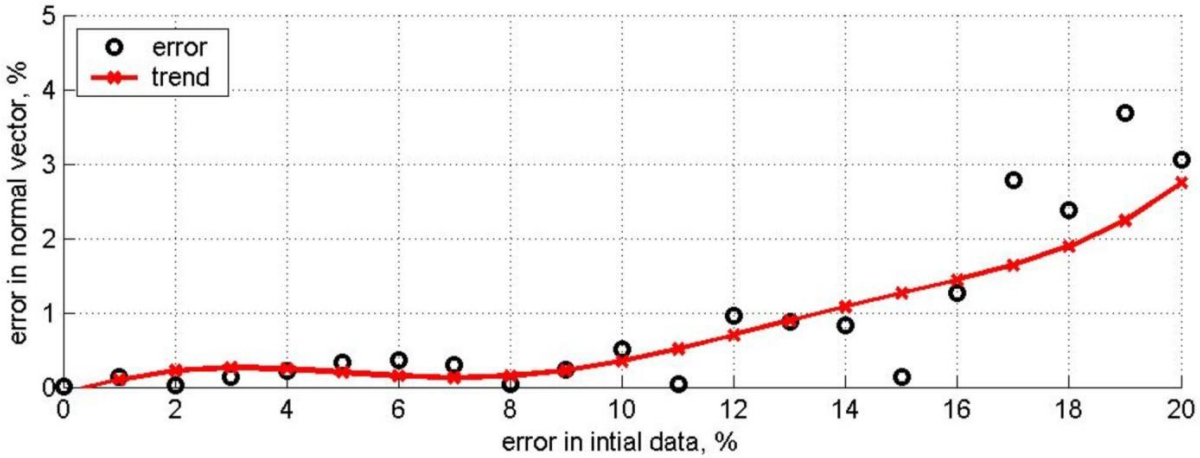
2) $$[\hat{\boldsymbol{\sigma}}\mathbf{n}]_\Gamma = 0, \quad \Rightarrow \quad \rho = \rho_2 / \rho_1.$$

3) $$k_P = \frac{d_1 - \rho}{d_1 + \rho}, \quad k_S = \frac{d_3 - \rho d_2}{d_3 + \rho d_2},$$

$$\mathbf{k}_P = k_P \mathbf{n}, \quad \mathbf{k}_S = k_S \mathbf{n}.$$

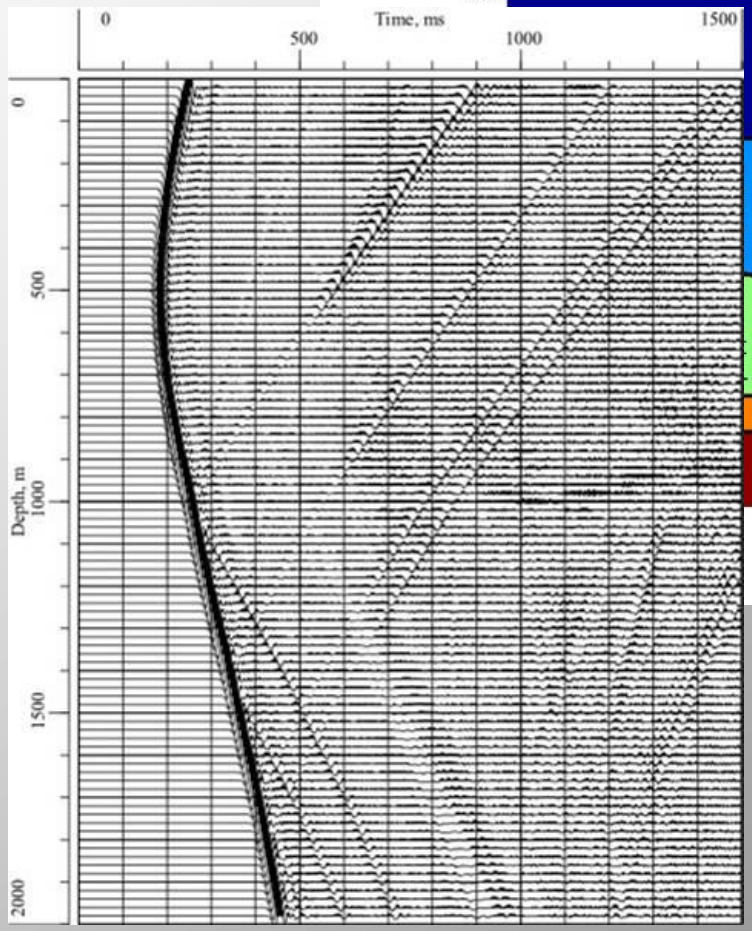
Stability of the procedure

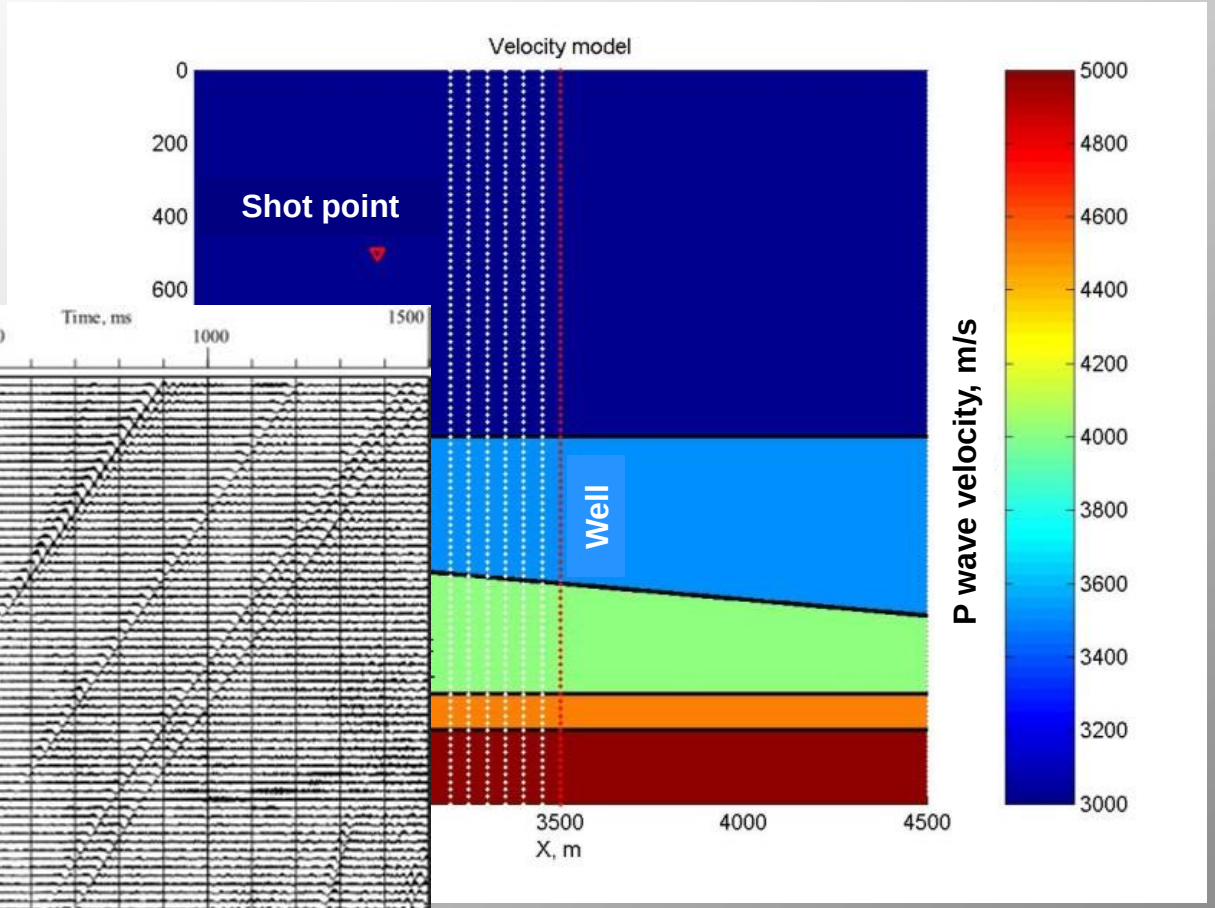




Synthetic example

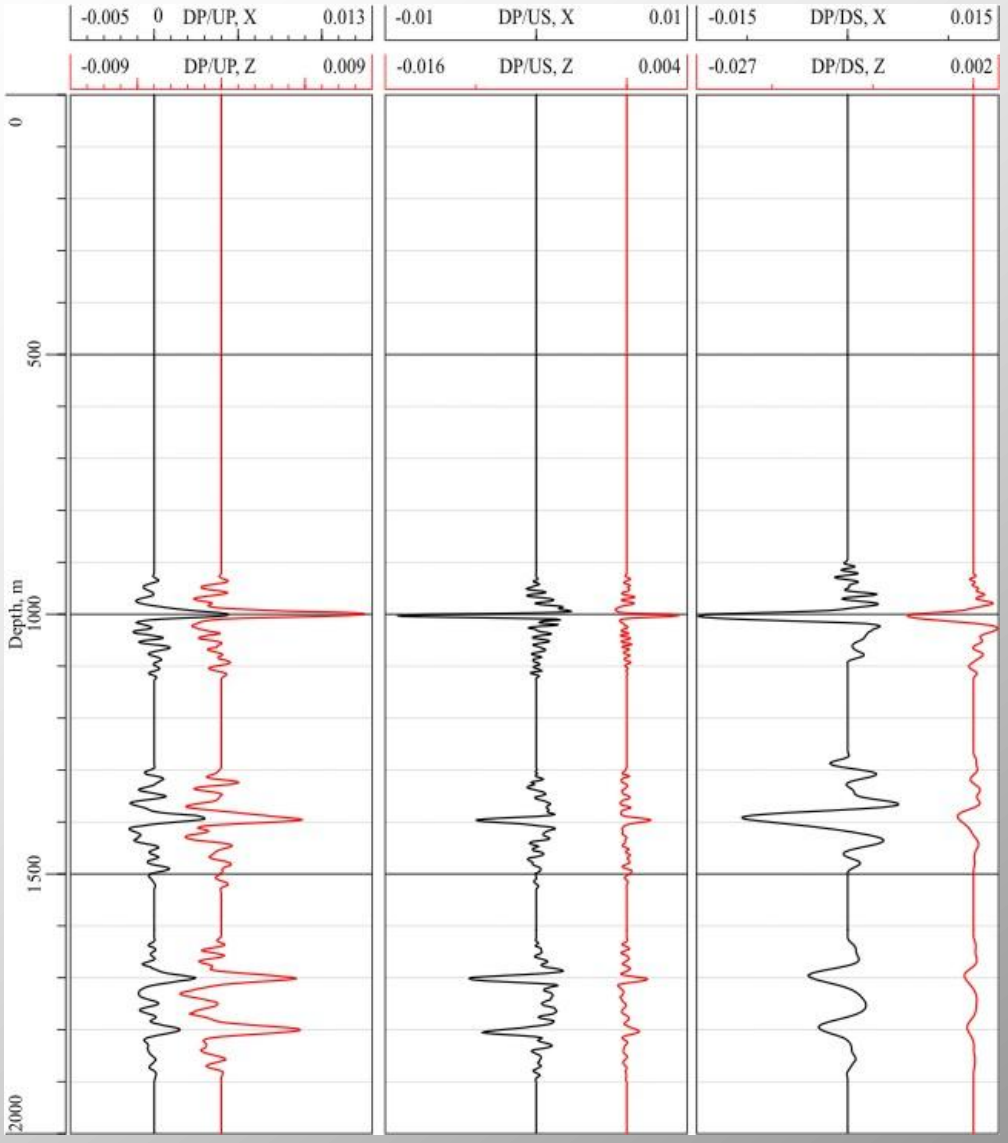
Synthetic VSP





Reference velocity model of the media

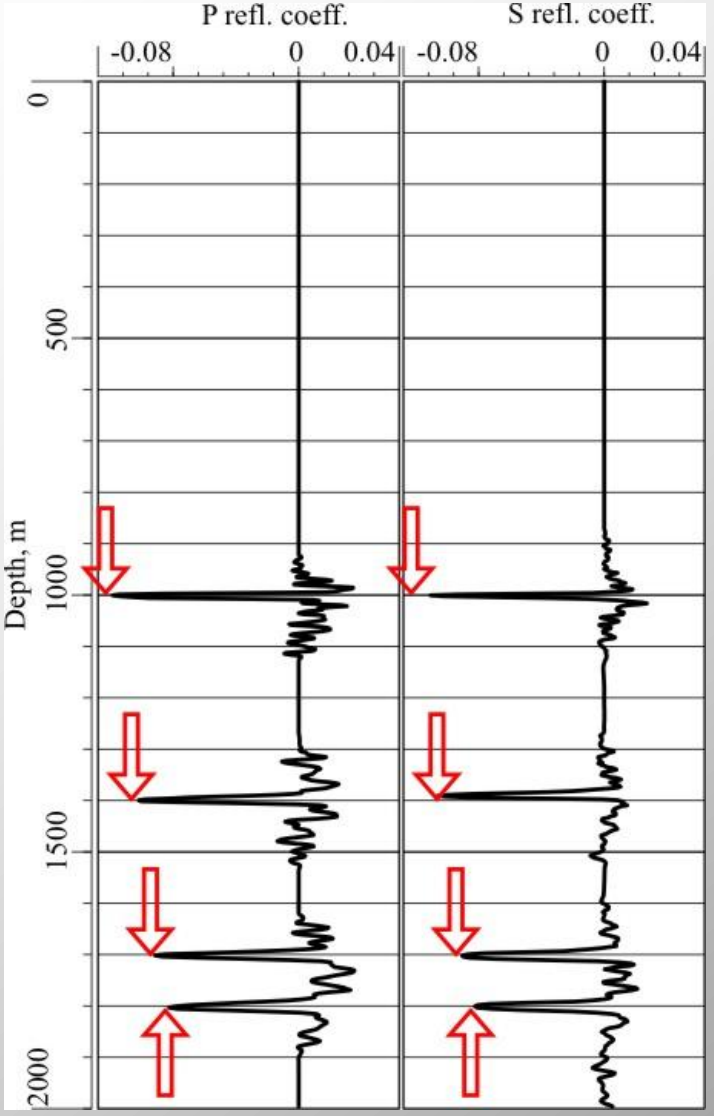
Synthetic example



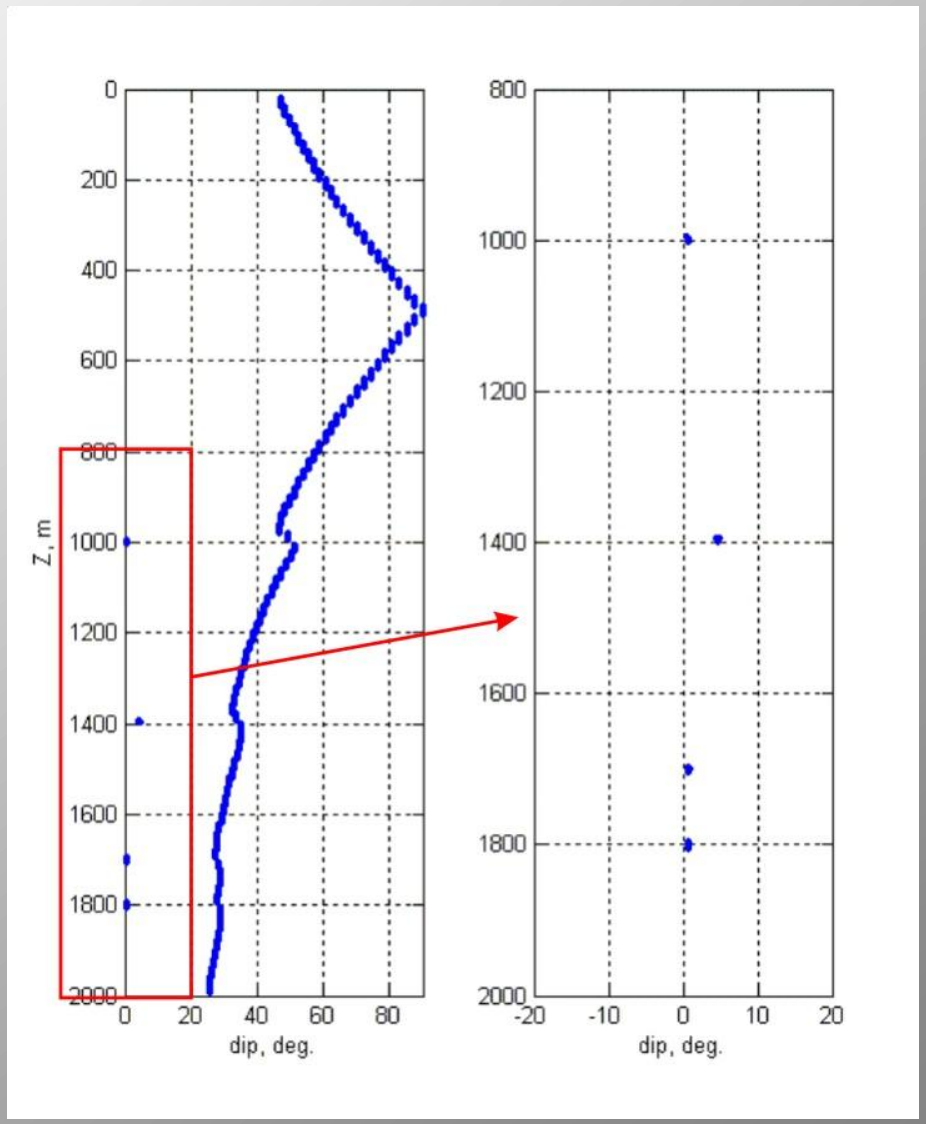
Vector “Corridor Stack” for

A) Upgoing PP waves
B) Upgoing PS waves
C) Downgoing PS waves

Synthetic example



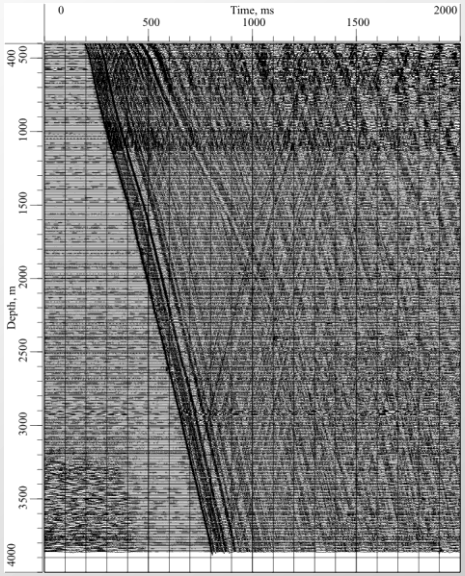
Normal reflection coefficients for P and S waves



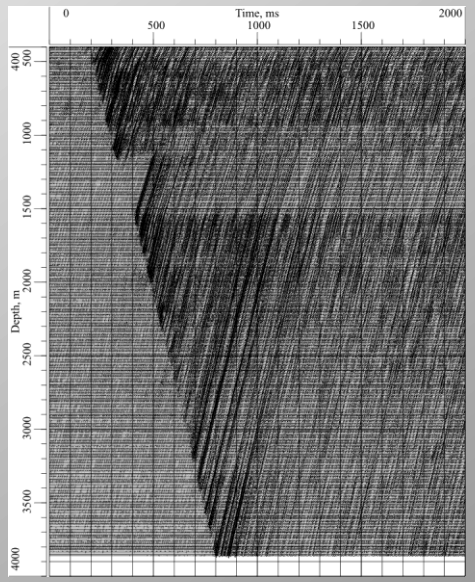
Dip angle

Real data example

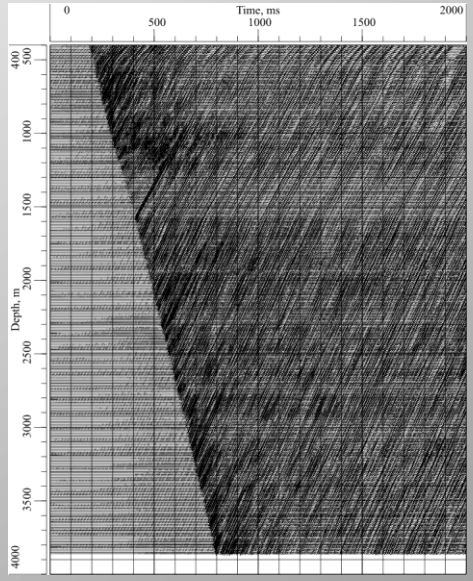
Raw VSP data



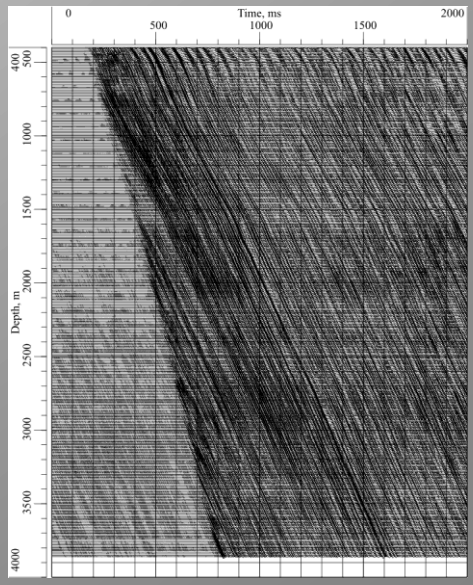
Upgoing PP waves



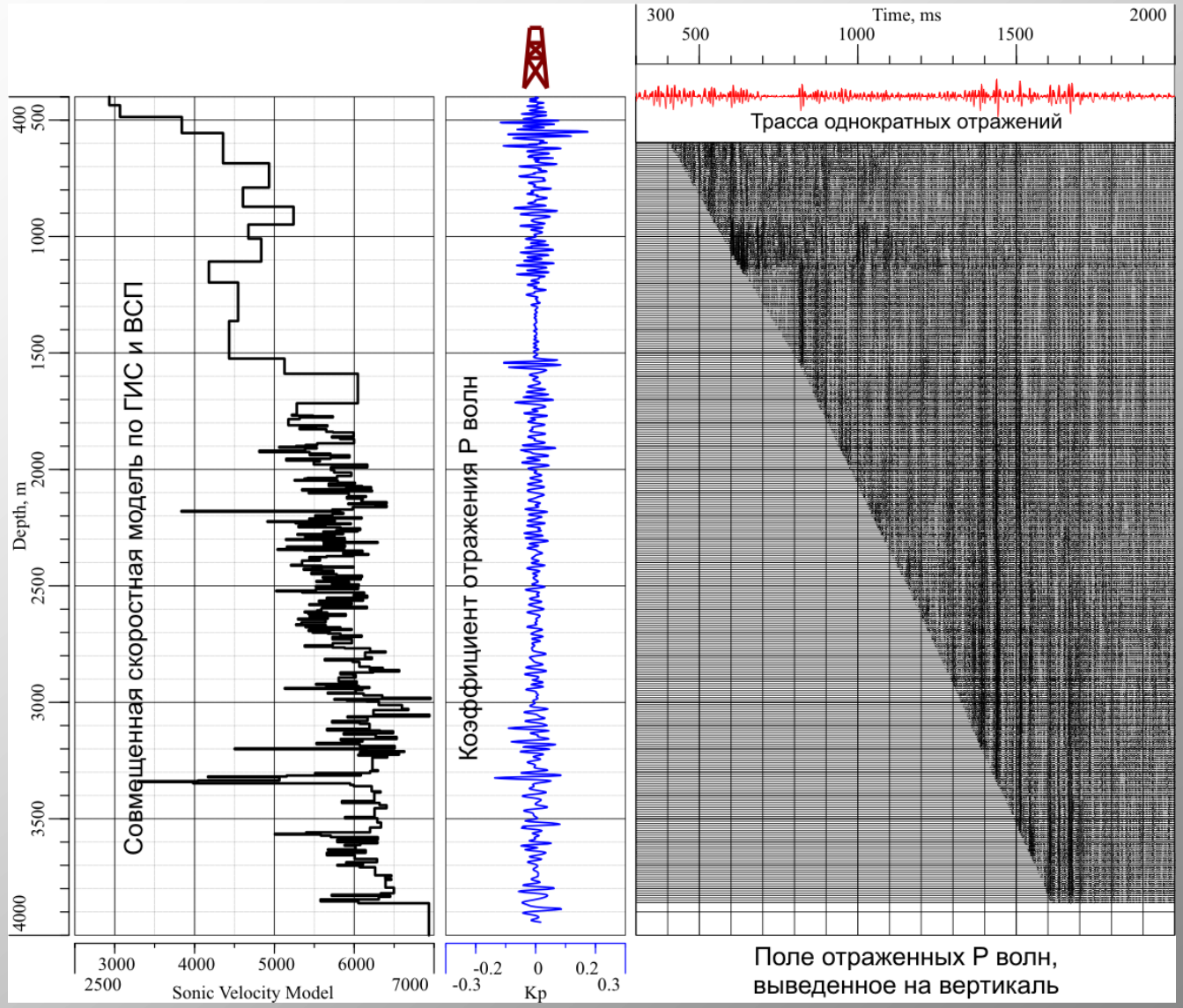
Upgoing PS waves



Downgoing PS waves



Real data example



Velocity model, PP reflection coefficient and upgoing P waves wave field

Vector inversion: the way to 2D vector imaging

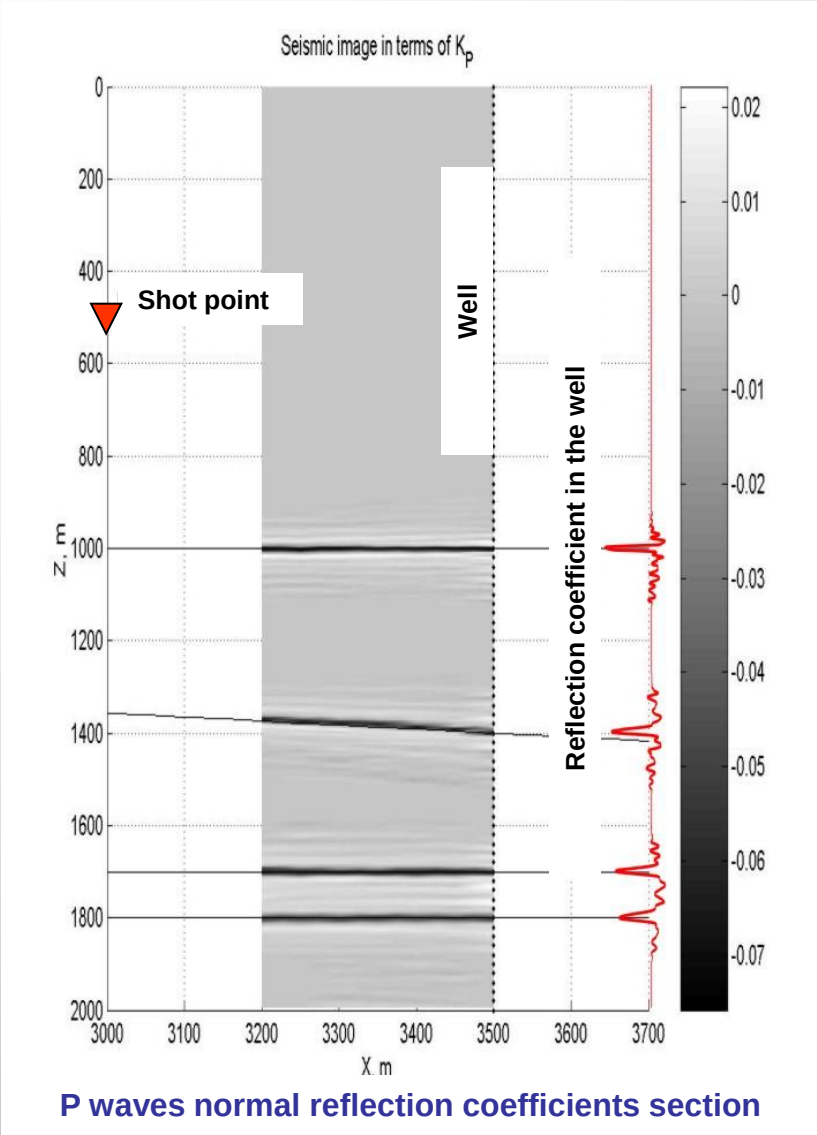
1. Extrapolation of the source wave-field and recording extrapolated field on the additional vertical profiles

2. Wave selection and deconvolution of extrapolated vertical seismic profiles data, obtain vector “corridor stack” for all types of waves

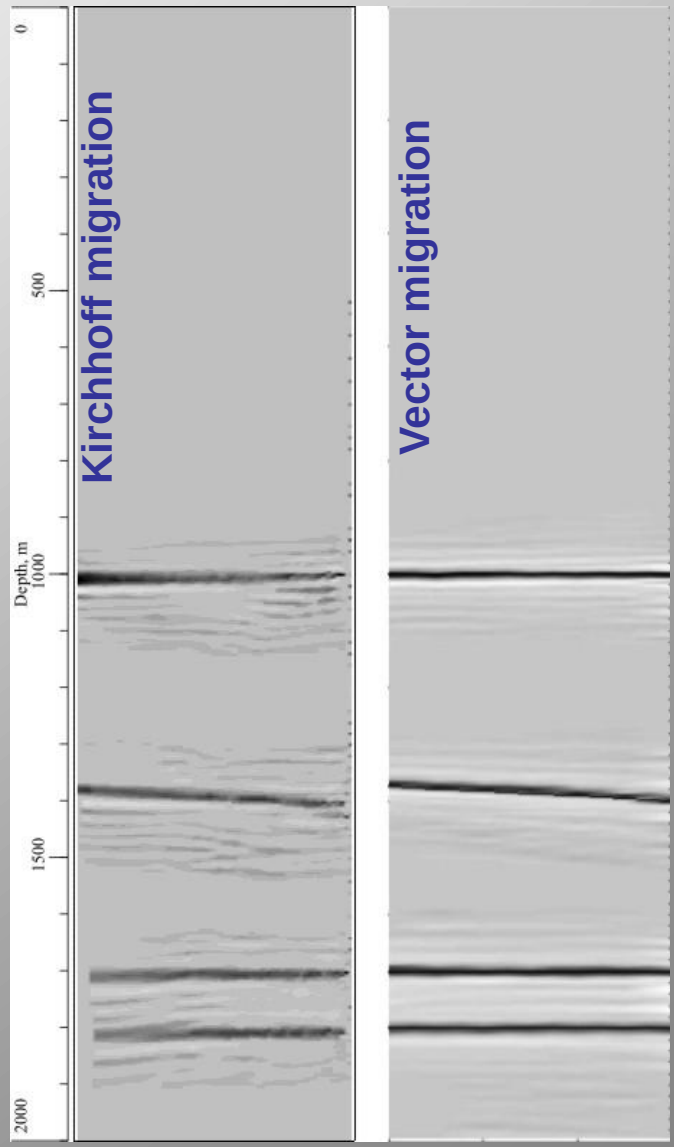
3. Vector inversion of extrapolated VSP data

4. Composition of normal reflection coefficients section

Vector inversion: the way to 2D vector imaging



P waves normal reflection coefficients section



Conclusions

1. Acquired solution of the inverse dynamic problem for ray scattering model allows to recover common elastic parameters such as reflection coefficients for normal incidence as well as normal vector to the boundary

2. Computational procedure has been successfully tested both on synthetic and real VSP data

3. Vector inversion combined with the procedure of the wave field extrapolation yields an algorithm for 2D vector elastic migration-inversion