

Harmonic experiments with data from paper 91 using effective single-phase phase fluids

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Abstract

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Keywords: poroelasticity, anisotropy, velocity dispersion, finite elements.

Data for the dry frame of solid 1 (calcite, illite, quartz) at 3100 m next were taken from Ariel EXCEL files. Data for Kerogen considered as solid 2 were taken from paper 91, as well as water, oil and gas properties. For the bulk modulus of the solid grains K_s in solid 1 (calcite, quartz, illite) we used the value 28.4 Pa in paper 91.

Solid 1 properties as read from EXCEL are:

- (1) $\rho_s = 2313 \text{ kg/m}^3$,
- (2) $\phi = 5.3 \%$,
- (3) $\kappa = 0.15 \cdot 10^{-18} \text{ m}^2$,
- (4) $km_V = 18.546 \text{ Pa}$,
- (5) $\mu_V = 7.69 \text{ Pa}$.
- (6) $km_H = 22.138 \text{ Pa}$,
- (7) $\mu_V = 9.909 \text{ Pa}$.
- (8) $vp_{dry}V = 3626 \text{ m/s}$
- (9) $vs_{dry}V = 1873.66 \text{ m/s}$
- (10) $vp_{dry}H = 4017.33 \text{ m/s}$
- (11) $vs_{dry}H = 2127.0 \text{ m/s}$

Using the porosity ϕ and density ρ_s we computed km_V , μ_V were obtained from the (dry, core) velocities in the V- row in the EXCEL file at 3103 m depth, while km_H , μ_H were obtained from the H-row in the EXCEL file at 3103 m depth.

Solid 1 is saturated with 99 % gas and 1% water, while solid 2 is saturated with 99 % gas and 1% oil.

The sample is a square of diameter 2 mm discretized with a 60×60 mesh.

The material consists of a periodic layered medium of solid 1 and solid 2 of 30 periods, each layer of mesh size $h = 1.666 \cdot 10^{-5} \text{ m}$.

1 Numerical experiments

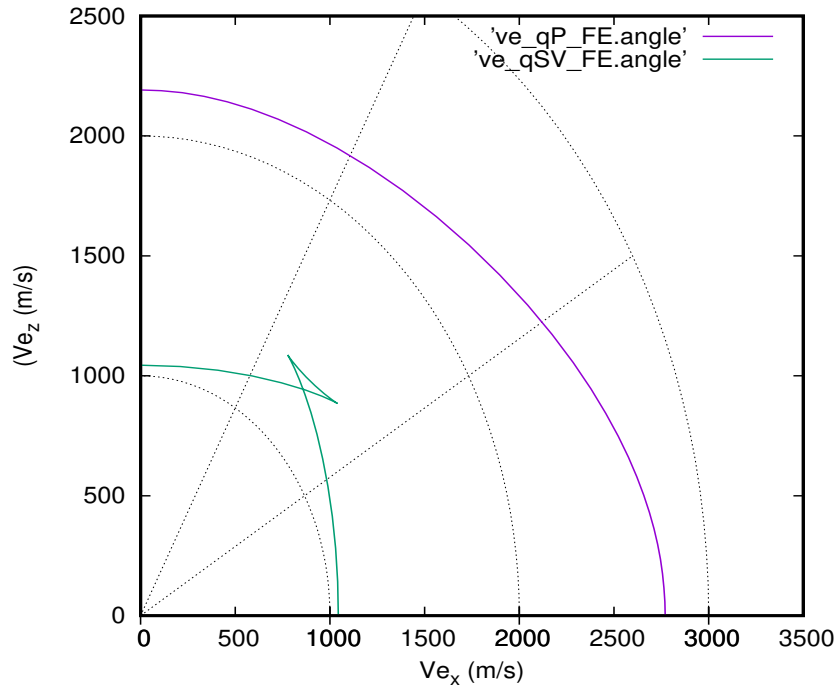


Fig. 1. Polar representation of energy velocities of qP and qSV waves at 50 Hz. The sample consists in 30 periods of porous solids 1 and 2 both saturated with effective fluids. 1-1 Relation using V-data (1 layer of solid 1, 1 layer of solid 2 that repeats 30 times).

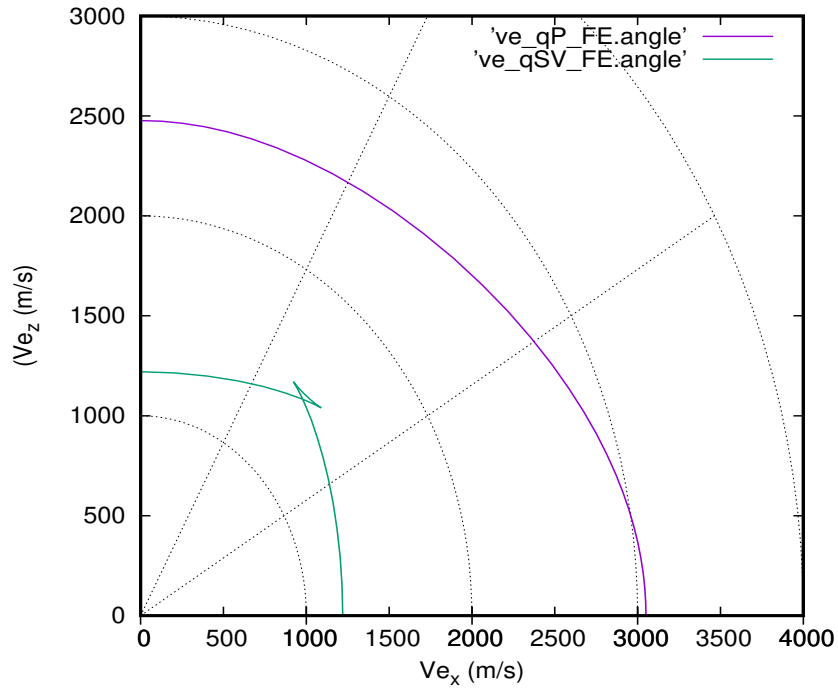


Fig. 2. Polar representation of energy velocities of qP and qSV waves at 50 Hz. The sample consists in 10 periods of porous solids 1 and 2 both saturated with effective fluids. 4-2 Relation using V-data (4 layers of solid 1, 2 layer of solid 2 that repeats 10 times)

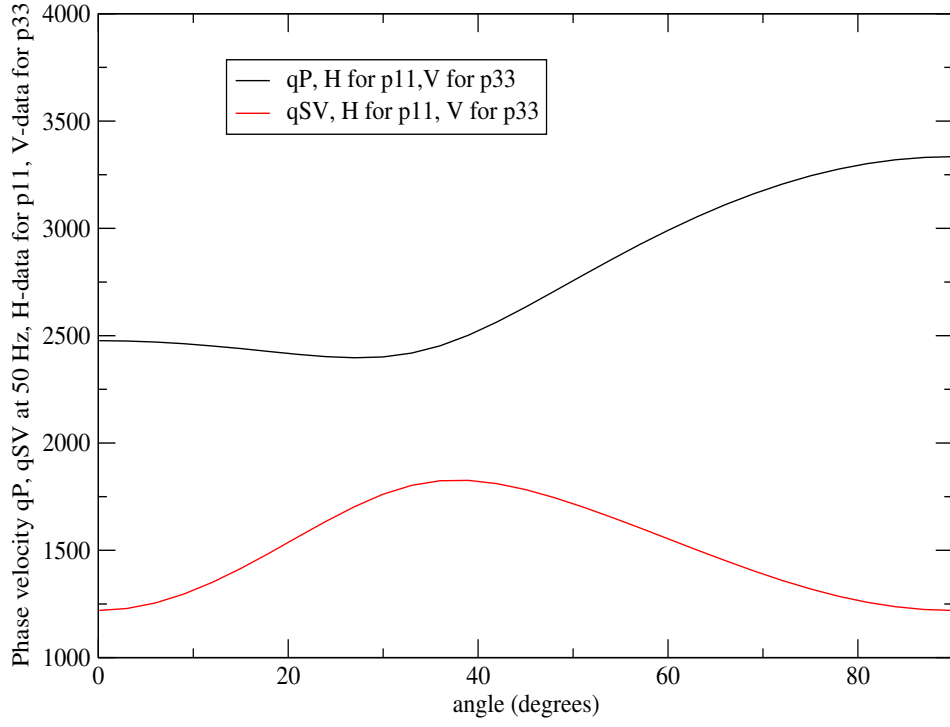


Fig. 3. Qp and qSV waves at 50 Hz as function of angle. The sample consists in 10 periods of porous solids 1 and 2 both saturated with effective fluids. 4-2 Relation using H-data for p11 and V-data for p33. This means that k_m and μ are computed from H-velocities for p11 and V-velocities for p33 (4 layers of solid 1, 2 layer of solid 2 that repeats 10 times)

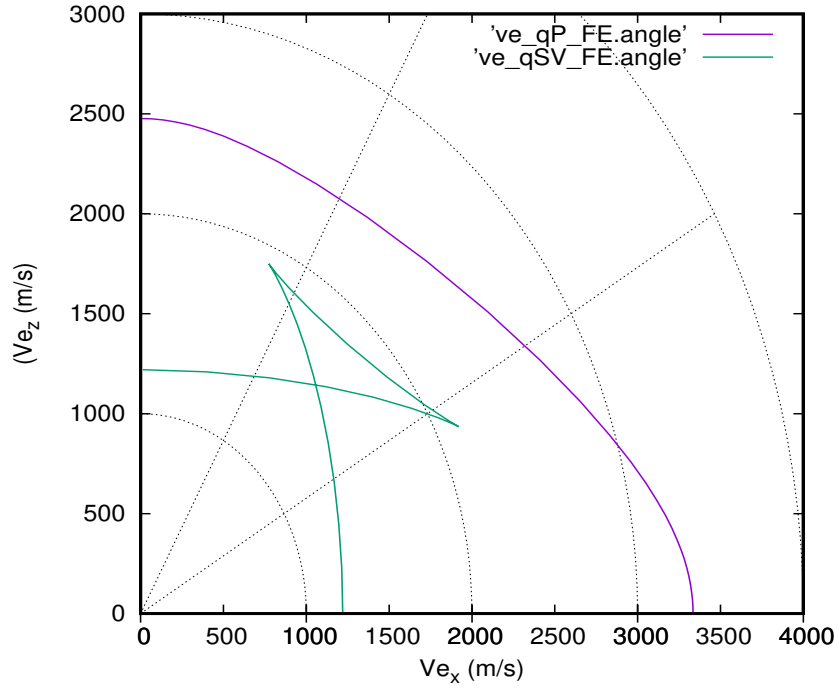


Fig. 4. Polar representation of energy velocities of qP and qSV waves at 50 Hz. The sample consists in 10 periods of porous solids 1 and 2 both saturated with effective fluids. 4-2 Relation using H-data for p11 and V-data for p33. This means that k_m and μ are computed from H-velocities for p11 and V-velocities for p33 (4 layers of solid 1, 2 layer of solid 2 that repeats 10 times)

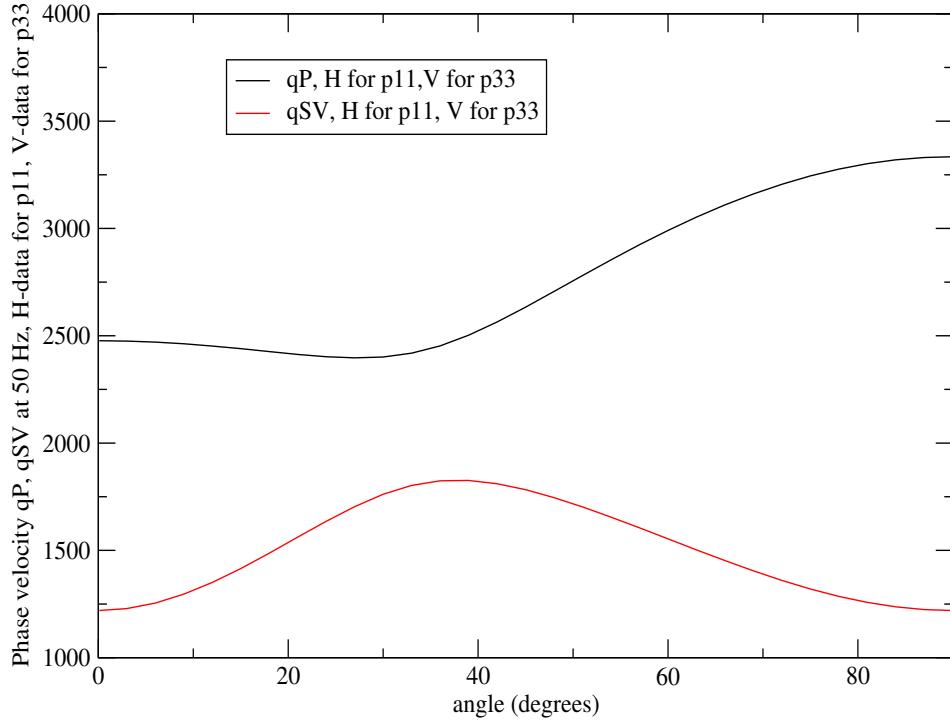


Fig. 5. Phase velocity of '11' and '33' waves (parallel and normal to the layering plane) as function of angle. The sample consists in 10 periods of porous solids 1 and 2 both saturated with effective fluids. 4-2 Relation using H-data for p11 and V-data for p33 (4 layers of solid 1, 2 layer of solid 2 that repeats 10 times)

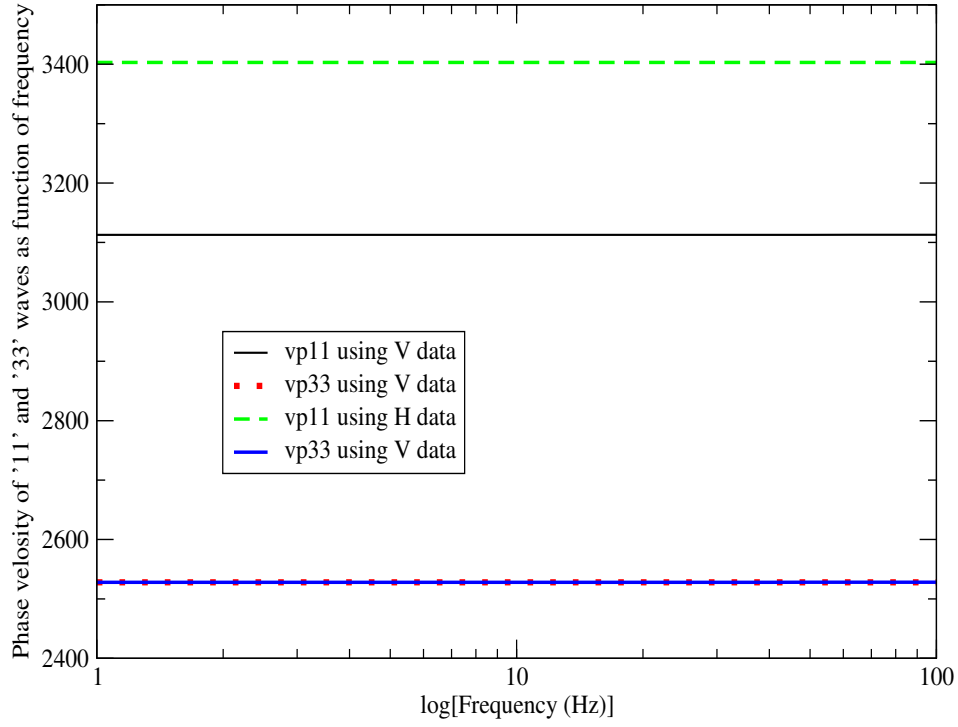


Fig. 6. Phase velocity of '11' and '33' waves (parallel and normal to the layering plane) as function of frequency. The sample consists in 10 periods of porous solids 1 and 2 both saturated with effective fluids. 4-2 Relation. using V and H-data for p11 and V-data for p33 (4 layers of solid 1, 2 layer of solid 2 that repeats 10 times)