

TEST 18. Experiments using dry core data depth 3098.68

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SUMMARY

This experiment assumes 79 layers of Material composed of 7 minerals including 23 % kero-
gen as a mineral. Material 1 has 6 % porosity

Also we have 1 layer of Material 2 consisting of kerogen with porosity 6 % with properties as
in Propiedades-minerales.pdf que mando Ariel para el mu.

Layer 1 has proportions as in code Voight-Reuss-Ariel.f (Configuracion 1) but changed to get
porosity 6 %

f1 = 0.2300d0 of Kerogen

f2 = 0.3727d0 of Clay

f3 = 0.1461d0 of Quartz

f4 = 0.1068d0 of Calcite

f5 = 0.0257d0 of Plagioclase

f6 = 0.0237d0 of Dolomite

f7 = 0.035d0 of Pyrite

Key words: layered VTI media, finite Element, harmonic experiments

1 INTRODUCTION

2 TEST 18

Depth 3094.68 m as in Notas.pdf from Ariel

2.1 data for 7 minerals with kerogen as mineral 7

Fluid properties

K-air = 1.01325d5 (Pa)

rho-air = 1.225d0 kg/m^3

eta-air = 1.805d-5 Pa . s

K-water = 2.25d9 (Pa)

rho-water = 1000.d0 kg/m^3

eta-water = 0.001d0 Pa . s

Minerals density

rhos-calcite = 2800.d0 kg/m^3 density of Calcite (mineral 1)

rhos-dolomite = 2900.d0 kg/m^3 density of Dolomite (mineral 2)

rhos-clay = 2700.d0 kg/m^3 density of Clay (mineral 3)

rhos-quartz = 2700.d0 kg/m^3 density of Quartz (mineral 4)

rhos-plagioclase = 2800.d0 kg/m^3 density of plagioclase (mineral 5)

rhos-pyrite = 5000.d0 kg/m^3 density of pyrite (mineral 6)

rhos-kerogen = 1400.d0 kg/m^3 density of kerogen (mineral 7)

Proportions of Calcite, Dolomite, Clay, Quartz, plagioclase, pyrite

phi1 = 0.23 Kerogen proportion

phi2 = 0.3727 Clay proportion

phi3 = 0.1461 Quartz proportion

$\phi_4 = 0.1068$ Calcite proportion

$\phi_5 = 0.0257$ Plagioclase proportion

$\phi_6 = 0.0237$ Dolomite proportion

$\phi_7 = 0.035$ Pyrite porportion

porosity (ϕ_8) = 0.06

Material properties of minerals and air as a fluid

$K_1 = 7.0 \cdot 10^9$ Kerogen bulk modulus (GPa)

$K_2 = 25. \cdot 10^9$ Clay bulk modulus (GPa)

$K_3 = 45. \cdot 10^9$ Quartz bulk modulus (GPa)

$K_4 = 80. \cdot 10^9$ Calcite bulk modulus (GPa)

$K_5 = 80. \cdot 10^9$ plagioclase bulk modulus (GPa)

$K_6 = 100. \cdot 10^9$ bulk modulus Dolomite (GPa)

$K_7 = 170 \cdot 10^9$ pyrite bulk modulus (GPa)

$\mu_1 = 2. \cdot 10^9$ Kerogen shear modulus (GPa)

$\mu_2 = 7. \cdot 10^9$ Shear modulus Clay (GPa)

$\mu_3 = 50. \cdot 10^9$ Shear modulus Quartz (GPa)

$\mu_4 = 35 \cdot 10^9$ shear modulus calcite (GPa)

$\mu_5 = 35 \cdot 10^9$ Shear modulus plagioclase

$\mu_6 = 45. \cdot 10^9$ shear modulus dolomite (GPa)

$\mu_7 = 100. \cdot 10^9$ Shear modulus pyrite

With this bulk moduli of each mineral and a generalized Krief as in paper 42 we get the values

K_m y μ_m of the composite rock (Material 1)

$K_m = 29.19$ (GPa)

$\mu_m = 15.69$ (GPa)

We also computed

K-Reuss (GPa) = 18.83

K-Voight (GPa) = 38.74

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$\mu\text{-Reuss (GPa)} = 5.68$

$\mu\text{-Voight (GPa)} = 20.82$

Other input data for the pij codes:

Ks computed using the Biot coefficient alpha measured in the dry code

alpha = 0.15 and using Km computed as explained above:

$Ks = Km / (1 - \alpha)$

yields

$Ks = 34.34 \text{ (GPa)}$ (goes to the input files of the pij codes)

We also computed the average density of material 1 (goes to the input files of the pij codes)

Composite density of material 1 = 2486.69 kg/m^3

For material 2 (Kerogen) we have 1 layer of porosity 6 % with properties

$ks(2) = 7.d+9 \text{ Mod. Bulk granos solidos (Pa) Kerogen}$

$ros(2) = 1400.d0 \text{ densidad granos solidos (kg/m}^3$

$km(2) = 1.29d+9 \text{ GPa Kerogen}$

$mum(2) = 0.36d+9 \text{ GPa Kerogen}$

$\phi(2) = 0.06d0 \text{ porosidad}$

$\kappa(2) = 2.75d-18 \text{ permeabilidad (m}^2$

Additional data is

Air density = 1.225 kg/m^3

water density = 1000 kg/m^3

air bulk modulus K-air = 1.0132510^5 (Pa)

Air viscosity eta-air = $1.80510^{-5} \text{ (Pa} \cdot \text{s)}$

water viscosity = $0.001d0 \text{ (Pa} \cdot \text{s)}$

VTI experiments

We run the pij codes using the above data

We use in the input file

for a 1 mm thickness square sample

number of periods: 1

mesh size: $1.25 \cdot 10^{-5}$

size of layer 1 in subintervals 79

size of layer 1 (m) $9.875 \cdot 10^{-4}$

size of layer 2 (Kerogen)in subintervals 1

size of layer 2 (m) $1.25 \cdot 10^{-5}$

2.2 Computed VTI phase velocities using the dry-core data.

Table 1 summarizes the results of the VTI experiments on a 1 mm thickness dry sample having 1 periods of 79 dry layers with a combination 7 minerals including kerogen and 1 dry Kerogen layer.

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Table 1. Phase velocities from the harmonic experiments and the measured ones, error percentage. Measured values were taken from file Notas.pdf. Frequency is 100 kHz

Phase velocity vp (m/s)	Computed	Measured	Percentage error
v11	4538.29	4331	4.79 %
v33	4008.93	4217.47	4.96 %
v55	2098.69	2193.61	4.33 %
v66	2581.97	??	?? %

Table 2. Numerical p_{ij} values from the VTI experiments. Frequency is 100 kHz

p11
(47881607223.002250, 34039.066160)
p33
(37362983980.381652, 223305.323451)
p55
(10239564921.821903, 0.0)
p66
(10239564921.827581, 0.0)