

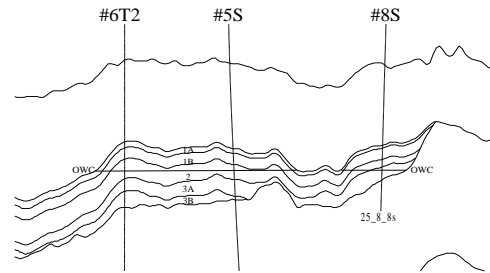
RESERVOIR GEOPHYSICS AT UOB

- Introduction
- Some relevant items
 - from rock physics
 - from seismic modelling
 - from seismic inversion
 - from applications
- Discussion

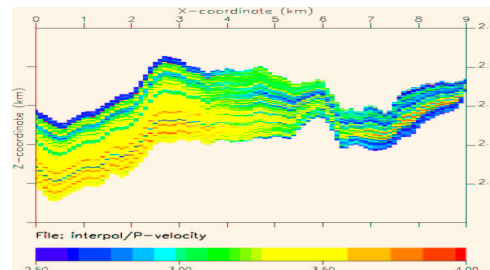


RESERVOIR GEOPHYSICS:

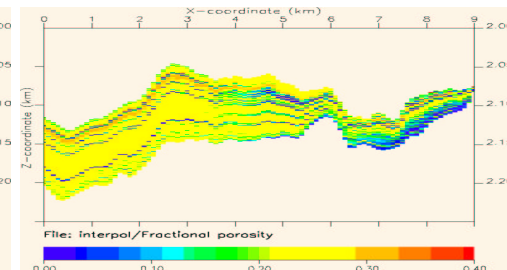
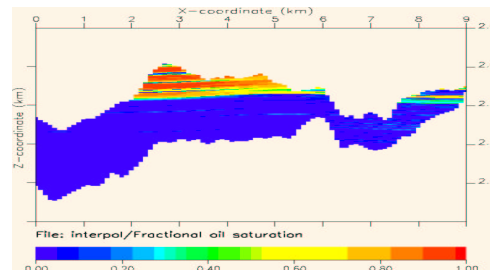
- derive a *geometrical image* of the reservoir elements



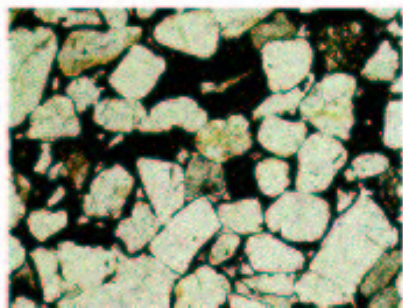
- derive relevant *layer parameters*



- derive the *dynamics* of layer parameters



ROCK PROPERTIES VS. SEISMIC PROPERTIES:



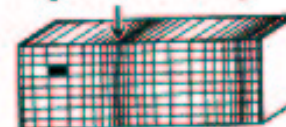
Rock physics



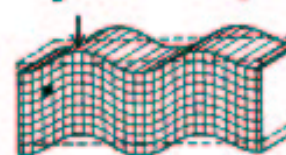
$$\begin{aligned}V_P &= 2.6 \text{ km/s} \\V_S &= 1.4 \text{ km/s} \\ \rho &= 2.2 \text{ g/cm}^3\end{aligned}$$

minerals
fluids
porosity
permeability
:

V_P : P-velocity



V_S : S-velocity



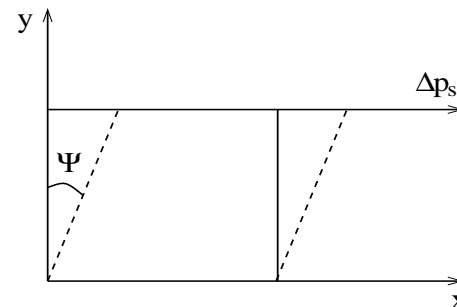
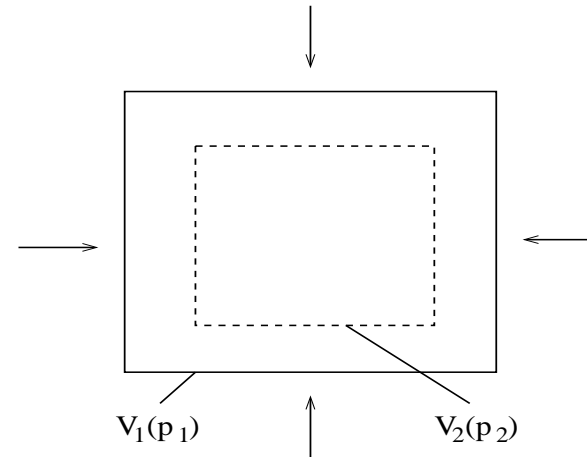
ELASTIC PROPERTIES OF ISOTROPIC MATERIALS:

$$v_p = \left(\frac{k + \frac{4}{3}\mu}{\rho} \right)^{\frac{1}{2}}$$

$$v_s = \left(\frac{\mu}{\rho} \right)^{\frac{1}{2}}$$

$$k = - \frac{p_2 - p_1}{\frac{v_2 - v_1}{v_1}}$$

$$\mu = \Delta p_s / \tan \rho$$



SEISMIC PROPERTIES:

P-wave sensitive to:

- Grain stiffnesses (lithology)
- + Fluid stiffness (type, saturation)
- + Pore geometry/grain contacts (permeability / transport properties)
- Porosity
- Cracks

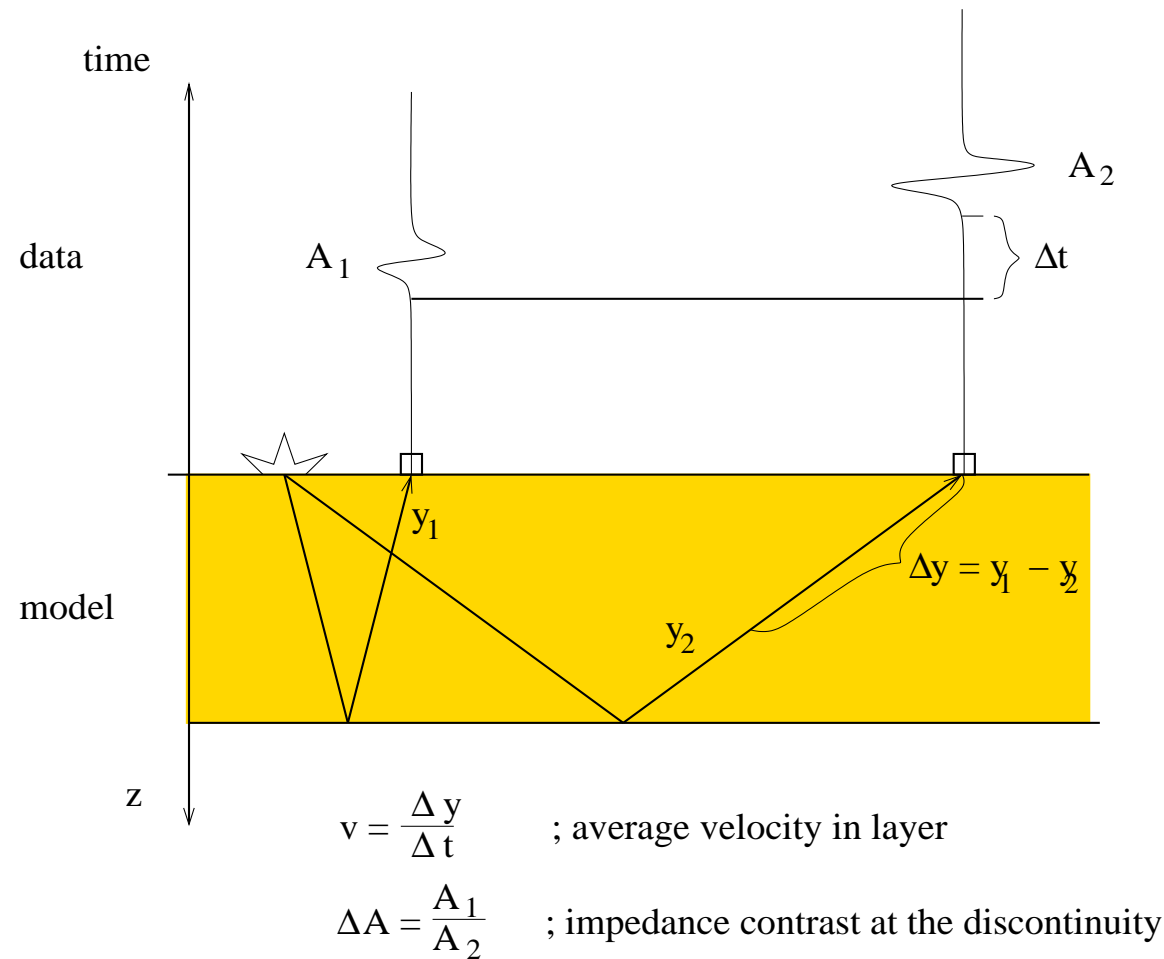
S-wave sensitive to:

- Grain stiffness
- ÷ Fluid stiffness
- ++ Pore geometry/grain contacts
- Porosity
- ++ Cracks

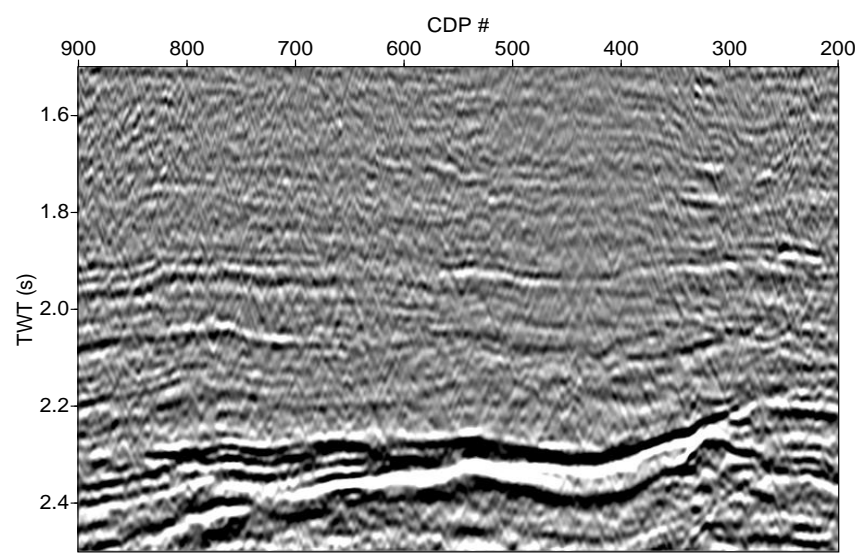
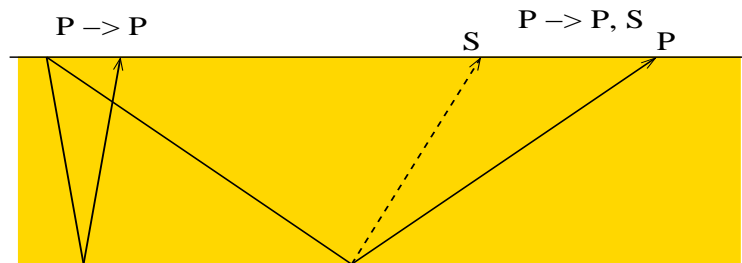
$V_P \sim V_S$ lithology, fluid, fluid vs pressure effects



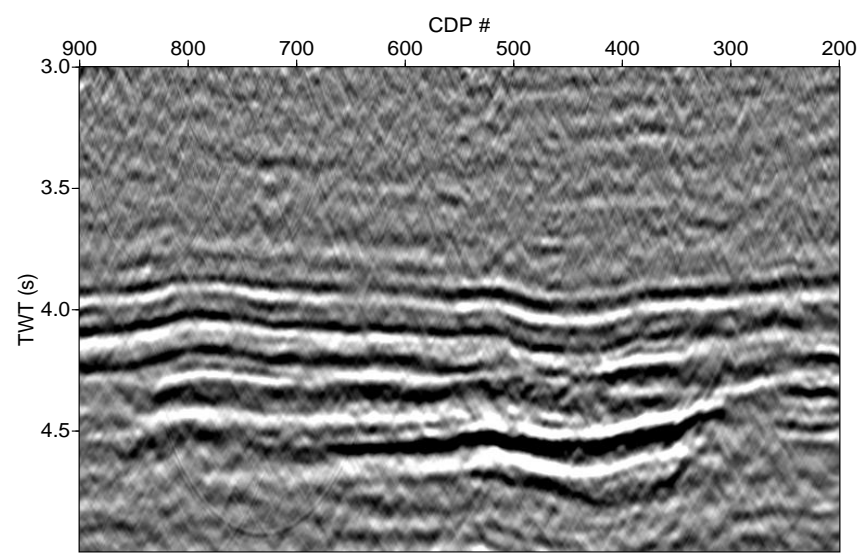
SEISMIC MEASUREMENTS



SEA BOTTOM RECORDING – PP AND PS WAVES



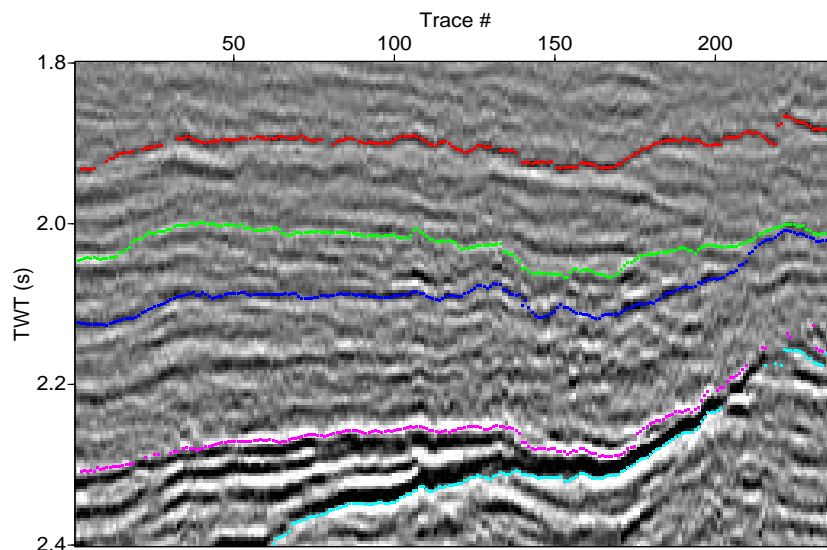
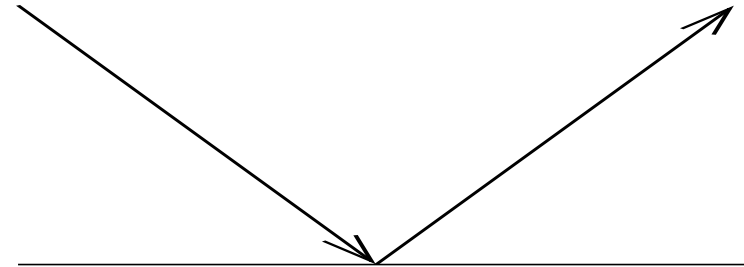
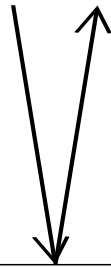
4C line - Vertical comp.



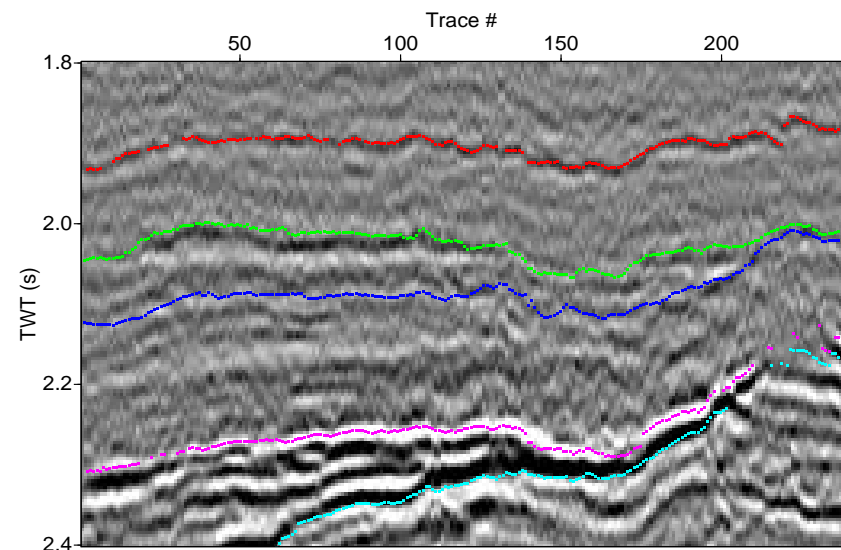
4C line - Inline comp.



'NORMAL' AND 'WIDE ANGLE' SEISMIC RESPONSE



Near stack 3D line

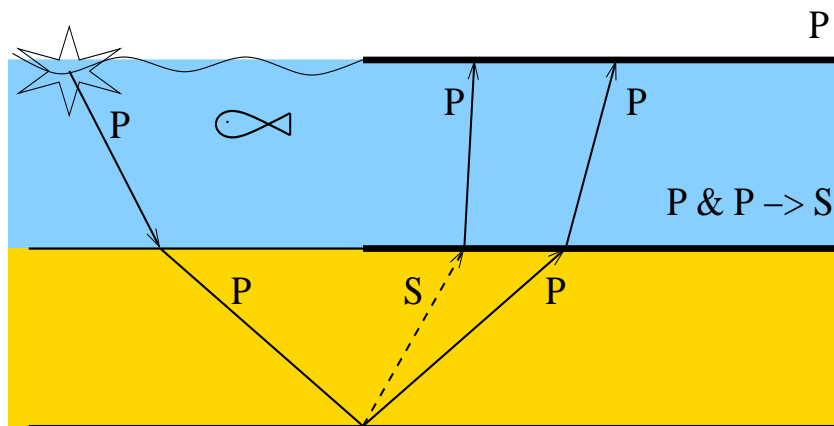


Far stack 3D line

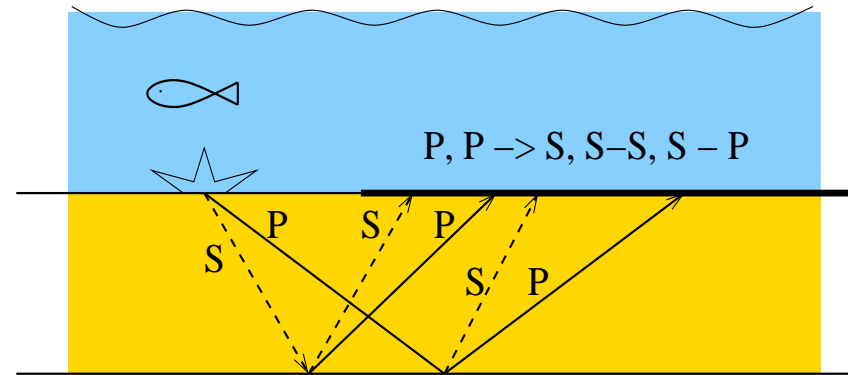


SEISMIC MEASUREMENTS

Seismic source at the sea surface



Seismic source at the seabottom

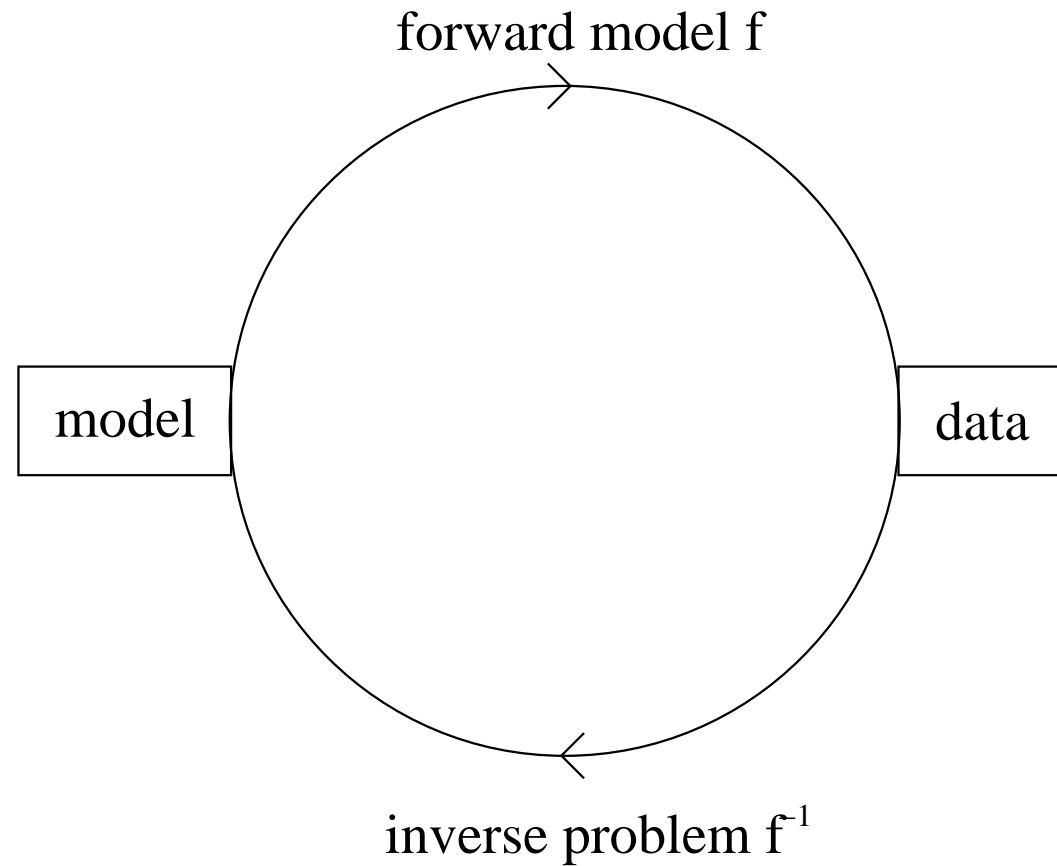


RESEARCH TOPICS:

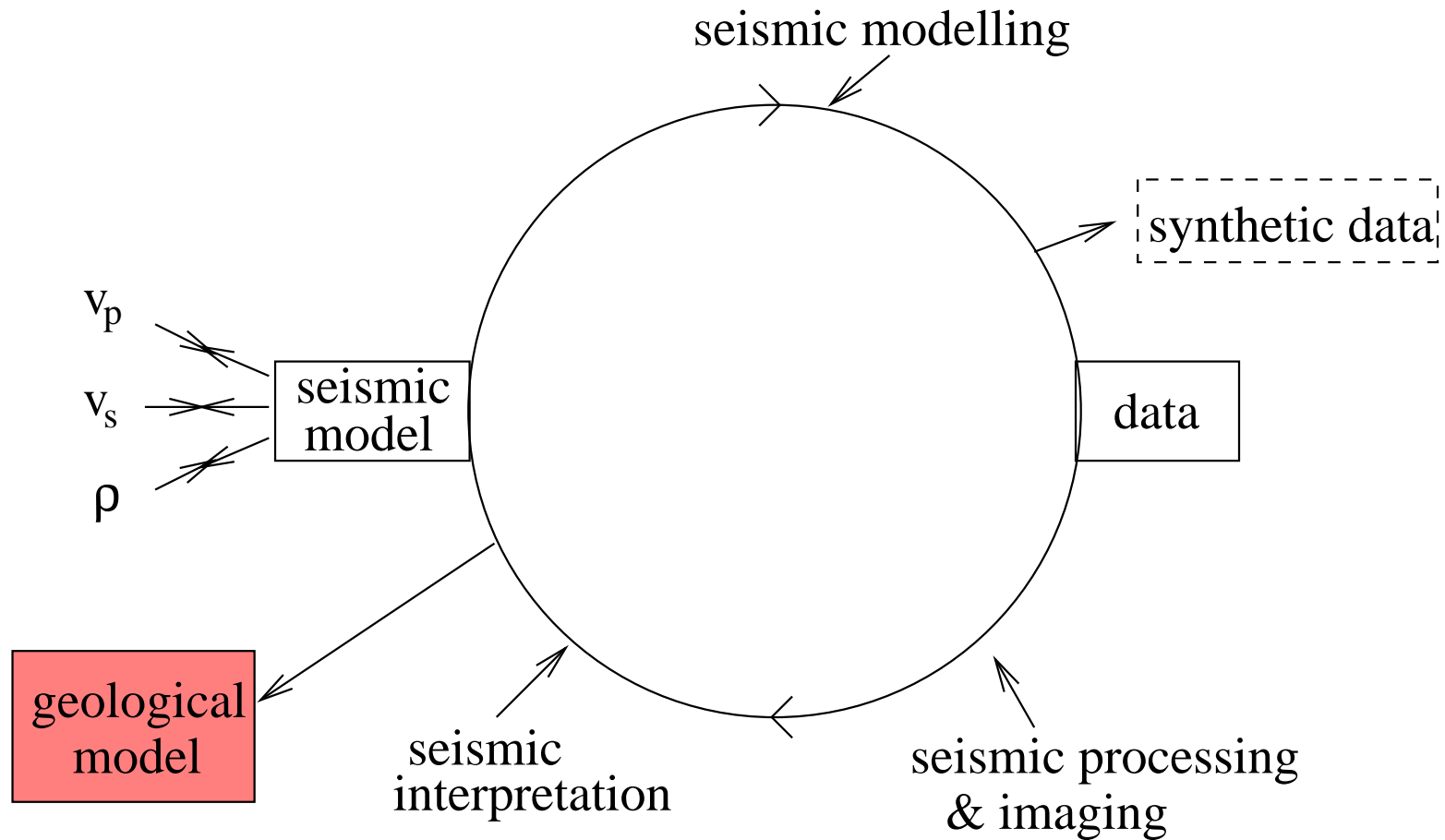
- Increase knowledge of how rock composition and texture affect V_P, V_S, \dots
 - theory
 - verification
 - inversion methods
- Upscaling
 - seismic model from well data
- Include reservoir parameters in seismic modelling
- Integrate reservoir modelling (fluid, pressure) and geology in seismic modelling
- Enhance precision in V_P and V_S by use of $P - S, S - S$ data
 - seismic systems at the sea bottom



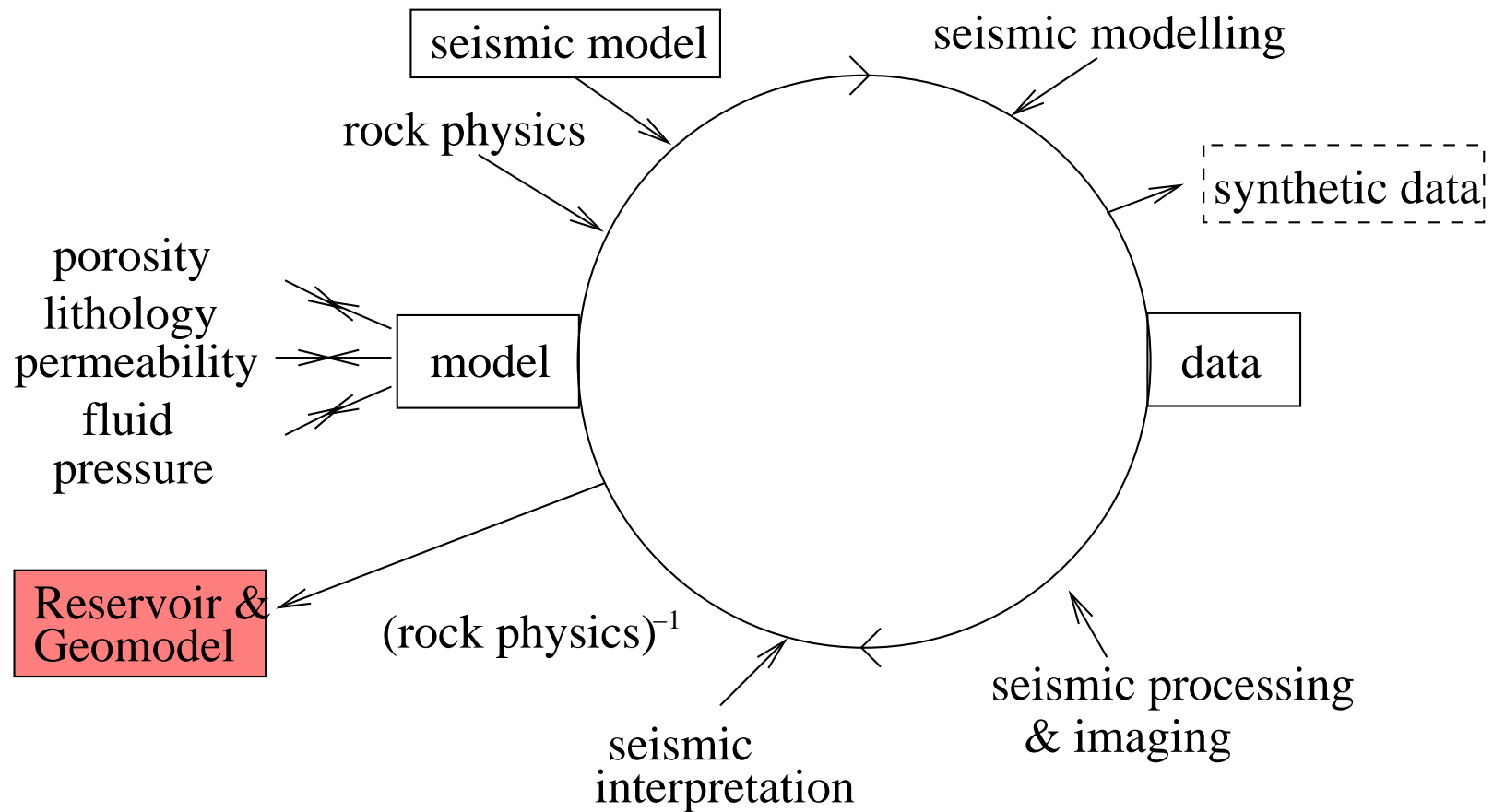
THE GENERAL PROBLEM



THE SEISMIC PROBLEM



THE 'INTEGRATED' PROBLEM



THE RESERVOIR GEOPHYSICS GROUP

Research Group:

Remy Agersborg, Ph.D. stud.
Ivar Brevik, Adj.Prof., Statoil
Anders Dræge, Ph.D. stud.
Åsmund Drottning, Dr.Scient., Scientist – NORSAR
Håvar Gjøystdal, Adj.Prof., NORSAR
Morten Jakobsen, Dr.Scient., Scientist
Erling Hugo Jensen, Cand.Scient., Research assistant
Tor Arne Johansen, Prof.
Bent Ole Ruud, Dr.Philos., Scientist

Current master students:

Ingrid Drange
Petter Nielsen
Kristina Pedersen
Øystein Rossebø



CAND. SCIENT. FROM RESERVOIR GEOPHYSICS GROUP

Espen Torgersen (1998). Integrated geological and seismic modelling.

Roger Bakke (2000). Effects of interpolation and upscaling on log data.

Bjarte Myhren (2000). Inversion for acoustic impedance and rock properties.

Kristoffer Engenes (2001). Potential use of SH-waves for seismic mapping of pore fluids and lithology.

Ragnhild Ona (2001). Observations and modelling of anisotropic rock properties.

Helge Ivar Sognnes (2001). Seismic methods for quantifying gas hydrates.

Anders Dræge (2001). Effect of pressure on seismic velocities - a study of laboratory data.

Camilla Thorsen (2001). Prediction of rock properties from acoustic data in wells.

Fredrick Sam (2001). Seismic properties of shaley rocks.

Ronny Tømmerbakke (2002). Modelled pressure effects on seismic data.

Kjetil Helvig (2002). Prediksjon av bergartsparemetre fra seismiske attributter.

Hege Susanne Birkeland (2002). Seismic wave attenuation in fluid saturated rocks.



ONGOING PROJECTS

- Seismic Reservoir Characterization
- Integrated geological and seismic modelling
- Seismic properties of carbonates

Cooperation:

- NORSAR
- Norwegian universities
- Department of applied mathematics and theoretical physics (DAMPT), University of Cambridge
- Postgraduate Research Institute of Sedimentology, University of Reading
- Department of Geophysics, Stanford University
- Institute of Informatics, UoB
- Several oil companies



PRESENTATIONS

- The Effective Material Parameters of Real Media,
presented by Morten Jakobsen
- Model based reservoir analysis,
presented by Åsmund Drottning
- Inversion of reflection seismic data constrained by well log data,
presented by Bent Ole Ruud
- Use of seismics in CO₂ deposition,
presented by Ivar Brevik

