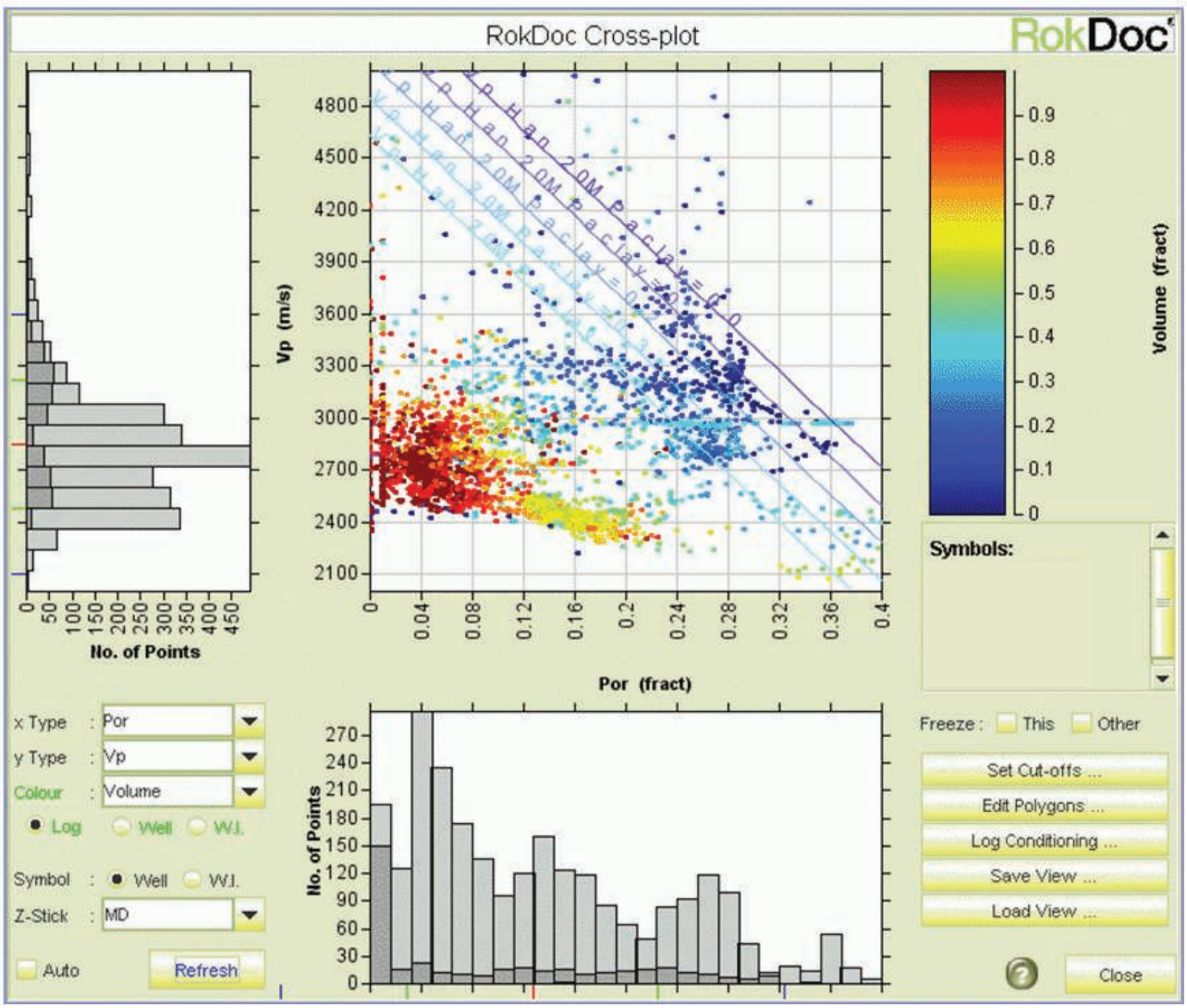
Rock Physics models

Why are they important?

Definition:

Rock Physics models describe the relationship between geophysical quantities e.g. reflectivity, impedance, gravity and EM-resistivity, that are derived from 3D surveys (seismic, electromagnetic and gravity) and the petrophysical quantities we would like e.g. facies, Vshale/NtG, porosity, saturation, pressure and permeability etc.

From the analysis of wellbore data (logs, core and MDTs), we know the petrophysical quantities at the wells. In order to establish the Rock Physics models, we correlate the petrophysical quantity to either the geophysical quantity extracted from the relevant survey at the well location or, if there is a good well match, by deriving the geophysical quantity from well logs e.g. Acoustic Impedance (AI) = Vp.Rho. These 'correlations' are usually performed by making 2D cross-plots with a petrophysical quantity on the horizontal axis, a geophysical parameter on the vertical axis and a secondary petrophysical parameter as the colour scale.



The blue lines on this Por/Vp cross-plot with Vshale as the colour bar, represents the well-known Han (1986) Rock Physics model.

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There are 3 families of Rock Physics models:

1. A real model that tries to explain the relationship between geophysical and petrophysical quantities using either physics or by applying trends to a large population of wells within a basin
2. Simple fits e.g. straight line, polynomial, exponential etc.
3. Statistical relationships - 'Cloud Transforms'

Importance of Rock Physics models:

- They may tell you something about your data. If a section of your well fits the Greenberg/Castagna shale line, then that section is likely to be shale. Or if it fits the constant cement model, you probably have constant cement (and the variability in the porosity/velocity cross-plot is likely the consequence of variations in sorting).

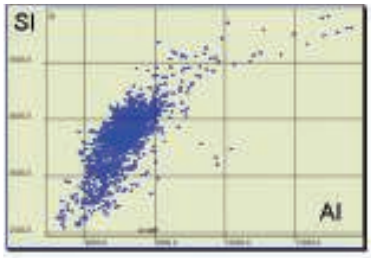
- We can use Rock Physics models to repair logs in a well or to synthesize an entire log absent in a particular well e.g. usually not all wells have Vs log

- In populating geological models, we can use Rock Physics models to capture and propagate the non-linearity between quantities e.g. porosity and permeability.

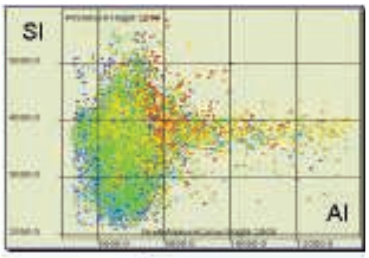
- Rock Physics models are able to constrain simultaneous inversions to, say, AI and SI (see below)

- Rock Physics models can be used to invert from geophysical quantities, for example one or two 'flavours' of impedance, to petrophysical properties e.g. porosity and pore-fill.

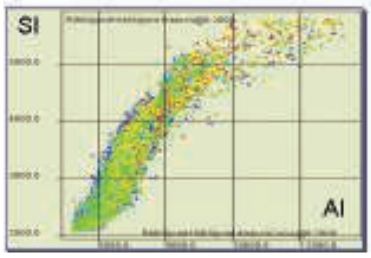
- Rock Physics models can be used to accurately model Depth Trends based on, for instance a compaction profile



Well log data
Shear Impedance Vs
Acoustic Impedance



Traditional inversion results, without a using a Rock Physics model.



Inversion results with a Rock Physics model

AI:SI statistics constrained by a Cloud Transform

See how a Rock Physics model - a statistical 'Cloud Transform' in this case - ensures the inverted data has the same characteristics of the well data

All these techniques are available within the RokDoc® platform.

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